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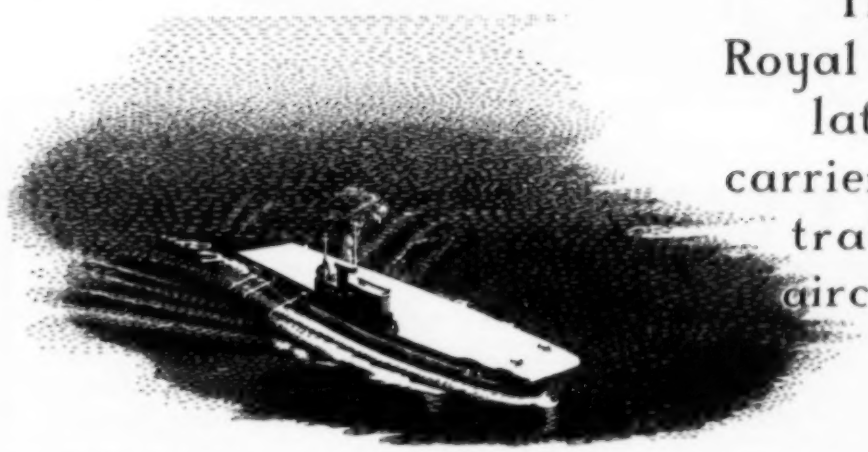

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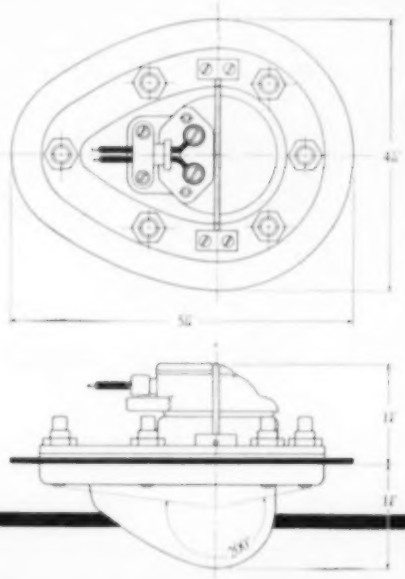

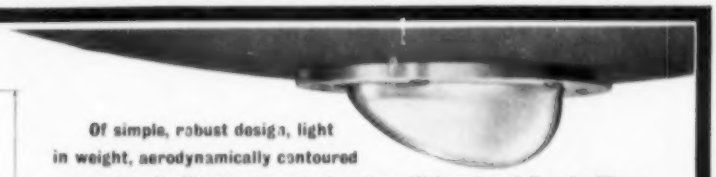

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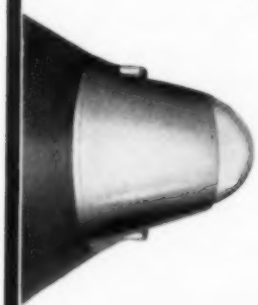

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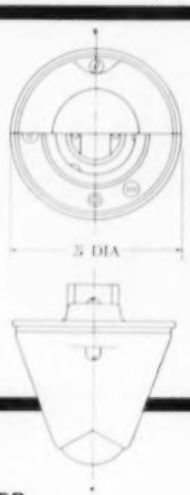

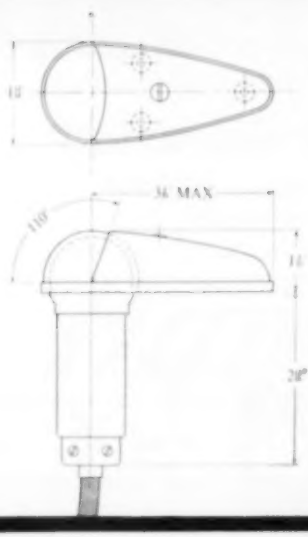

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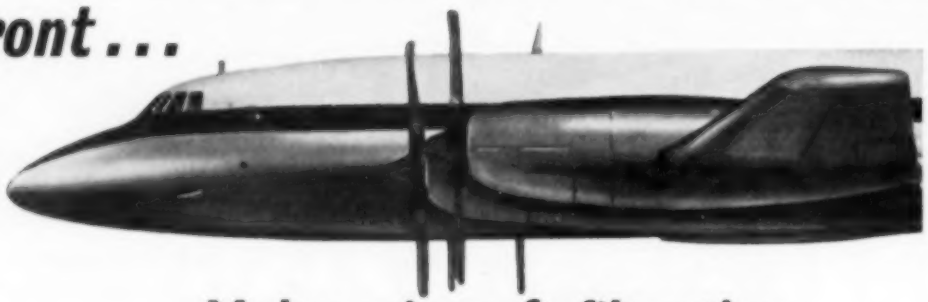

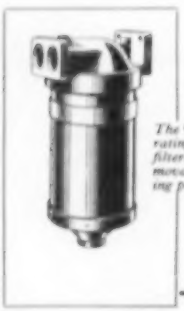

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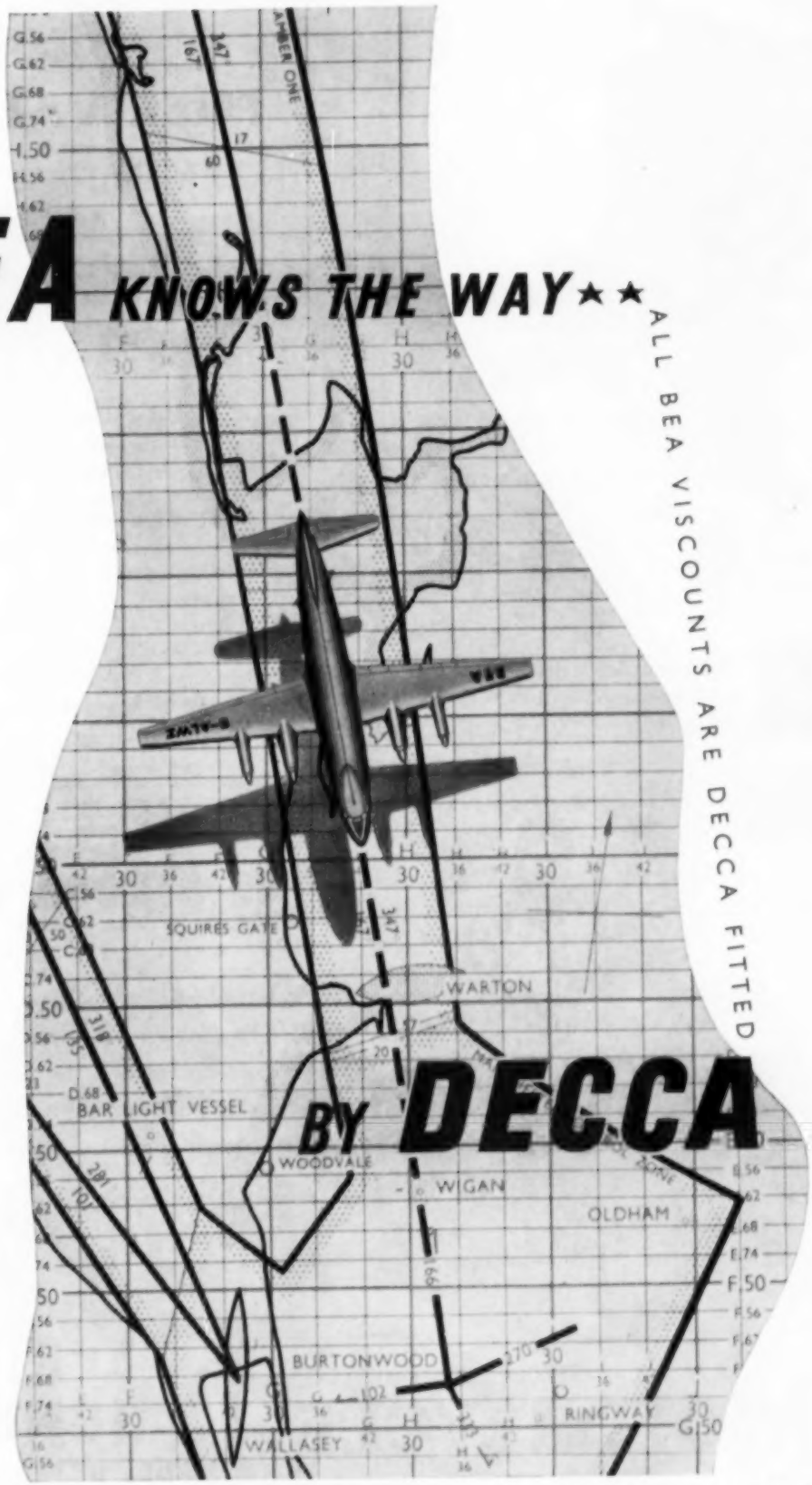

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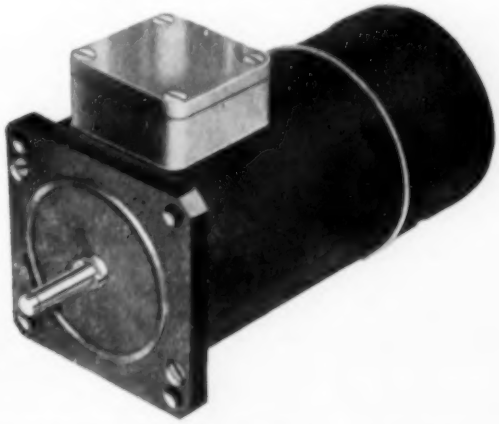

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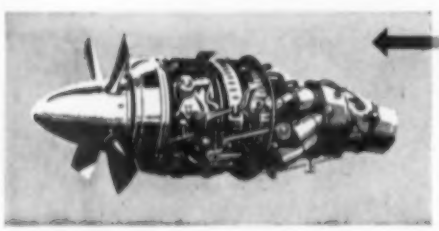

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The White Papers

IN all conscience, there is scant satisfaction to be found in the White Paper on *The Supply of Military Aircraft* issued last week. Nor is the *Statement on Defence* (both are abstracted in this issue) in any degree a balm. True, it might be said, in mitigation of the failures catalogued in the Supply paper, that Great Britain has no monopoly in development troubles, and that in these days the margin between a wholly successful military aircraft and a downright failure might be no more than a hair's breadth—yet not to be bridged by any reasonable amount of technical and financial expenditure. Then, depending on the construction put upon it, there may be some slight palliation in the claim that by night—the most likely time for an attack—we have a better defence than anyone else in the world. But if this be true, the credit is not to be arrogated to themselves by our planners, but must be acknowledged to that Providence which blessed us with a tight little island, and one now partly double-screened by Continental radar, backed by a sizeable force of British-made and American night fighters.

And if the night raider is, quite correctly, recognized as the biggest threat, why, it might be asked, is the all-important Javelin dismissed in a mere line and a half, whereas machines of far less significance are discussed at paragraph length?

Certain it is that, however the blame may be apportioned, the way of deliverance from our troubles will demand more from our national resources of clear thinking and ingenuity than we have been accustomed to draw upon in the post-war years. While learning from others it will avail us nothing to mouth parrot-fashion such shibboleths as "weapons system" unless some significance can be discerned in them.

But from these White Papers nothing but good can come. Upon their contents will be fought many a verbal engagement—and not in Parliament alone, but in the meeting places of Britons who are aware that their heritage may be imperilled as much by muddle and excess of caution as by direct assault of arms.

Interregnum

DURING the next decade an indeterminate amount of air traffic will be taken over by pure-jet transports. The exact proportion depends largely on the airline operators, whose own uncertainty is expressed in both word and action. Even B.O.A.C., whose faith in jet travel was re-affirmed last week by the decision to operate 20 "New Comets" (in place of a mixed fleet of 17 Series 2s and 3s) have also ordered turboprop types and even maintain an interest in an American piston-engine design for service in the near future. But whatever the ultimate future of jet transports as a class, the Comet remains a leader in that class; the lead has been lessened but not lost.

Intentions respecting America's Boeing 707 are already fairly clear, a limited quantity of a tanker/transport version—the KC-135—having been ordered into production for the U.S.A.F.; and though no firm orders have been booked for civil operators, Boeings are none the less hopeful of entering the commercial field with a version of the same aircraft. The decision, they inform us, "is dependent on military requirements and the financial feasibility of such an undertaking." Less venturesome, Douglas affirm that they have never released details or drawings of their DC-8 (notwithstanding published sketches and data), though they will admit that it would have four jets, would cruise at over 550 m.p.h. and would fly the Atlantic non-stop. But not until "market conditions warrant such a move," they assure us, will they release the design to the production line. Presumably a similar view is held by Lockheed, who have projects of their own for arterial jetliners, and by Fairchild, with their relatively short-ranged M.186.

In France the twin-Avon S.E. Caravelle (intended, like the Fairchild, for medium-haul work) fast nears completion, though the Hurel-Dubois H.D.45 has fallen by the way.

Meanwhile, the turboprop gains increasingly wide acceptance in fields where, only a few months back, the turbojet was bidding fair to prevail. That it will, indeed, prevail on the longest and most exacting routes is agreed by most authorities; and the belief that, in certain important respects, it can be made safer than the current piston-engine is a view hardly less widely accepted.

FOR LAND AND SEA: Recently the subject of successful trials, this amphibious D.H.C. Beaver, to which reference is made in a paragraph below, is equipped with standard main-wheels and brakes in addition to floats on which are carried free-swivelling nose-wheels.

FROM ALL QUARTERS

Formosa

IT appears that, up to now, the Chinese Nationalists have enjoyed air superiority in the immediate area of the offshore conflict, owing to the fact that they are able to bring to bear the full weight of their American-supplied air power, even though this consists of a comparatively small number of ageing types of fighters and light bombers. The fighters principally involved are thought to be about 500 F-47 Thunderbolts and F-84G Thunderjets, these being in process of reinforcement with a number of F-86 Sabres.

The Chinese Communists have numerical superiority in Mig-15s, but they have not yet been able to bring them to bear, because of a shortage of suitable airfields in the area. This they are now reported to be taking steps to rectify by modernizing a series of air bases in Fukien province opposite Formosa and the inshore Nationalist islands of Quemoy and Matsu. The largest of these bases, when complete, will probably be at Luchiao, 200 miles north of Formosa. When they are ready they will be able to operate both Mig-15s and Il-28s (Falcons and Butchers, by the new American nomenclature) for direct attacks on Formosa.

Night Fighters at Westminster

PARLIAMENTARY critics of the Government's aircraft-production programme have lost little time in returning to the attack, re-armed with ammunition collected from the White Paper on *The Supply of Military Aircraft*.

On Monday, Mr. George Wigg (Lab., Dudley) asked the Minister of Supply what type of British night fighter was capable of equalling the performance and fire-power of the United States' F-86D. Mr. Selwyn Lloyd replied that it would be wrong to give a detailed comparison between British and American aircraft which would involve disclosing secret matters. In any case, the F-86D was a single-seater night fighter, and we did not use this class.

Mr. Wigg said that the Minister ought to read the American and British technical Press, in which he could establish that the F-86D had a speed of 660 m.p.h., compared with our fastest all-weather fighter's 600 m.p.h. Also, he remarked, the American aircraft had "a double-disc radar". To this Mr. Selwyn Lloyd said it was quite profitless to draw comparisons between single- and twin-seat night fighters. He did not believe that the single-seat night fighter could operate in the climatic conditions of this country.

After a brief exchange of fire when Mr. Wigg referred to "the dishonest statement in the White Paper that our night fighter defences were the best in the world," Mr. Shinwell (Lab., Easington) pressed home the attack by asking if the claim was true in comparison with the U.S.A.F. To this Mr. Selwyn Lloyd replied that it most certainly was.

Was the Minister, persisted Mr. Shinwell, now saying categorically that our night air defence was superior to that of the United States?

Mr. Selwyn Lloyd: "I am saying it quite definitely. I am surprised that the right hon. gentleman, who himself was responsible for ordering many of these aircraft which he now seeks to deprecate, should want to do so."

In reply to a further question by Mr. Wigg, the Minister said that production was not yet completed of any of the four marks of Venoms, though the great bulk of the existing orders for the F.B.1s and the N.F.2s had been completed. In addition to orders placed previously, over 1,000 Venoms were ordered in the first nine months of 1951. Since October 1951, about 750 had been cancelled and 280 changed to later marks. No compensation had been paid, but materials and work done which were no longer required were being paid for at a total estimated cost of about £3,300,000.

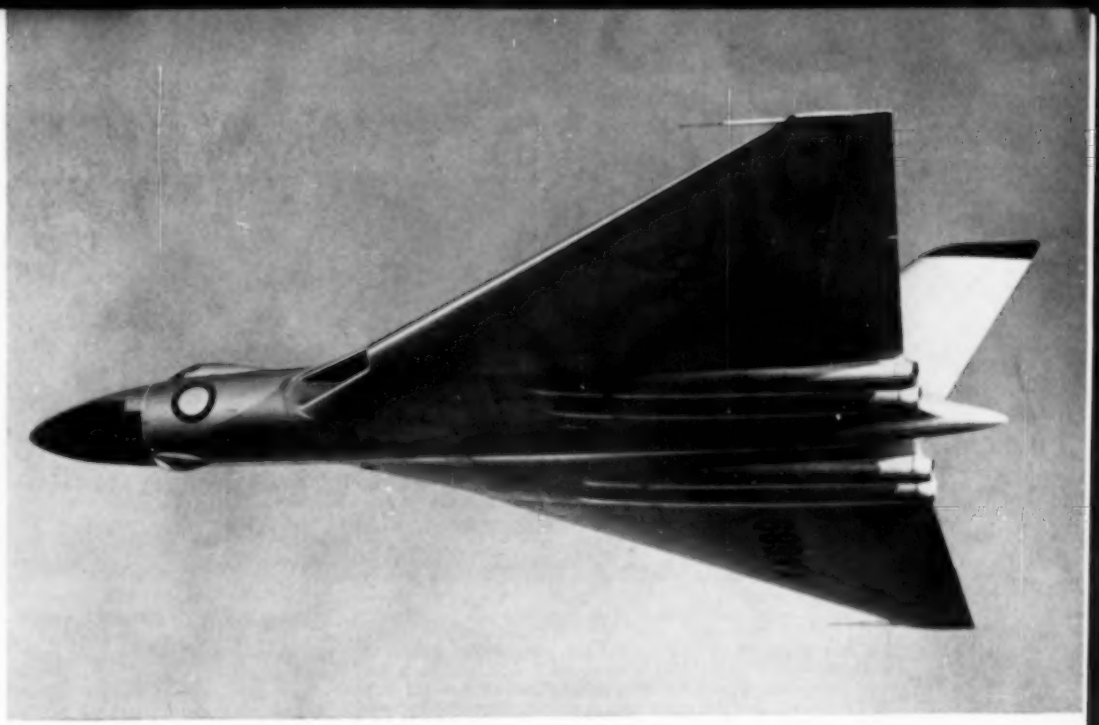
Editorial comment, p. 223; *Statement on Defence*, p. 227; *White Paper on Aircraft Supply*, p. 233.

Amphibious Beaver

EXTENDING still further the usefulness of the versatile Beaver now in large-scale production at Toronto by the de Havilland Aircraft of Canada, Ltd., Edo 4580 floats are to be offered in association with the normal wheels and brakes of the landplane version. The resulting amphibious Beaver is now to be made available this summer following the satisfactory completion of recent trials.

The fitting of amphibious floats is said to make no measurable difference to performance as compared with the normal seaplane version. The take-off distance in still air at maximum all-up weight is 900ft. By comparison with the landplane there is a

REFLECTION ON LANDING: (Right) Vice-Admiral T. S. Coombs, commanding the U.S. 6th Fleet in the Mediterranean, studies the landing mirror on the deck of H.M.S. "Albion." (Left) An F9F Cougar from U.S.S. "Lake Champlain," makes a touch-and-go landing. The occasion was a combined British-U.S. fleet exercise, during which the American aircraft tried out the new British landing aid. Seen with Vice-Admiral Coombs are Lt-Cdr. W. G. Cook (in flying kit), Cdr. P. C. Whitfield, O.B.E., R.N., Rear-Admiral A. R. Pedder, R.N. (Flag Officer Aircraft Carriers) and Lt-Cdr. S. F. Berthon, R.N.



ANOTHER VULCAN: *Just released by the M.o.S. for publication is this pleasing (in more than one sense) photograph presumably depicting the first production Avro Vulcan. It was taken up on its first flight earlier this month—as were the prototypes before it—by the company's superintendent of flying, Mr. Roly Falk, and its test flying programme is now in hand. Power is provided by four Bristol Olympus engines each giving 11,000 lb thrust.*

slight performance penalty; the "wheelphibious" take-off distance is 700ft. The wheeled undercarriage consists of two main-wheels and two free-castering nosewheels. The nosewheel units are mounted on the front bulkheads of the floats and they can be rotated up and over to lie on the float decks when not in use.

The mainwheels have levered rubber shock-absorbers and they are arranged to retract into wells in the floats just aft of the steps. A hand-pump operated in conjunction with a selector control in the cockpit serves hydraulic jacks for retraction of the wheels.

Burmese Viscounts

THOUGH the formal contract has not yet been signed, Union of Burma Airways have declared their intention to buy three Vickers-Armstrongs Viscounts for delivery late in 1956 or early in 1957. The announcement follows a recent demonstration in Rangoon by a T.A.A. Viscount passing through *en route* to Melbourne, and it is learned that the Burmese Government has approved in principle U.B.A.'s plan to buy the British turbo-prop. Vickers regard the Burmese market as an important one, in view of its influence on other South-East Asian operators.

Royal Patronage for Gliding

H.R.H. THE DUKE OF EDINBURGH has consented to become the Patron of the British Gliding Association. This was announced by Mr. Philip Wills, the B.G.A. chairman, after returning to this country last Monday from a visit to Australia and New Zealand. A B.G.A. official stated: "The Association is greatly honoured by this example of royal encouragement, and it is hoped that it will result in more people becoming airborne."

Missing DC-6 Found

ON February 21st, eight days after its disappearance on a scheduled flight from Brussels to Rome, Sabena DC-6 OO-SDB was found to have crashed on Mount Terminillo (6,700ft), 50 miles north-east of Rome. All 29 occupants, including a crew of eight, were killed. The last message from the DC-6, some fifteen minutes before it was due at Ciampino, had reported its position as over the Viterbo non-directional beacon, about 40 miles north-west of Rome and 45 miles west of Terminillo. Discovery of the wreckage followed an extensive land, sea and air search, involving up to 20 aircraft, including helicopters; the efforts of the search parties had been considerably hampered by heavy snow, which almost covered the remains of the aircraft.

L.R. Britannias: M.o.S. Order

ASKED in the House of Commons last week—by Mr. McKibbin (Con., Belfast E.)—what plans he had for placing further Government orders in Northern Ireland, Mr. Selwyn Lloyd, Minister of Supply, gave news of an order for three Mk 250 L.R. Britannias. The announcement was foreshadowed in our columns last week.

The Minister said he was about to place the order, adding: "The Government have under consideration plans for making these aircraft available on suitable terms to independent airline operators for trooping."

He continued: "The Bristol Aeroplane Company have informed me that on receipt of this order they will order the production of eight Britannias Mark 250 by Short Bros. and Harlands, in Belfast, with whom they are associated. The labour force needed to make these eight planes will build up to about 1,500 within about 18 months."

Following the Minister's announcement, the Bristol Aeroplane Co., Ltd., issued the following statement:—

"The Government order for three Britannia 250 L.R. aircraft for trooping operations enables the company and Short Bros. and Harland, Ltd., of Belfast, to carry a stage further their joint plans, first disclosed a little over a year ago, for the establishment of a second Britannia production line at Belfast . . .

"The Britannia 250 L.R. differs from the all-passenger version Britannia 300 L.R. in having the fuselage forward of the wing specially adapted for the carriage of heavy freight as an alternative to passengers.

"It has been decided, in anticipation of demand, to put in hand at Belfast an initial batch of eight Britannia 250 L.R. (the first three of which will be allocated to the present Government order), while the company's own works at Bristol will concentrate on the all-passenger aircraft."

It has also been learned that Qantas have now asked Bristols to make new proposals to supersede those which formed the basis of their earlier letter-of-intent to purchase six Britannias. Further details appear on page 253.

Snowdrop II

THE snowstorm which struck the north of Scotland last week steadily increased its severity until by the week-end its effects were thought likely to be even more serious than those which occasioned "Operation Snowdrop" a month earlier.

Once again appeals for help from the air began to arrive at Wick and R.A.F. Station, Kinloss. One helicopter stationed at Wick made several flights to bring in medical cases and deliver spare parts for electrical supply installations. The main requests, however, were for animal feeding-stuffs, particularly for starving sheep. Shackletons and Neptunes therefore once more took off to drop bales of hay, and Varsitys were prepared to join them. The number of helicopters at Wick was to be brought up to five.

Japanese Rocketry

JAPAN'S first research rockets, known by the names "Pencil" and "Baby" have been completed by a Tokyo University team, working under Prof. Hideo Ogawa. They are to be launched on March 5th at Kokubunji, Tokyo. The purpose of these radio-controlled rockets will be—in the words of the Tokyo report, which deserves quoting—"to conduct advance studies at high altitudes through which development of radio communication, aeronautics and prevention and forecast of natural hazards are expected."

According to Dr. Itogawa, another of the scientists engaged on the work, the main fuel employed is "nitro-glycerine and nitro-cellulose"; and the rockets will be made of "plastic and steel."

FROM ALL QUARTERS . . .

VENOM F.B.4: A new portrait of the latest Service-type de Havilland Venom single-seat fighter/bomber, powered with a D.H. Ghost 103 turbojet. Compared with earlier single-seat Venoms, this mark has "greater powers of control near the upper limits of its performance." Superficially it differs in tail design. Note also the under-wing—as well as tip-mounted—tanks.

Handley Page Lecture Meeting

AT a meeting of the Handley Page engineering society on February 15th, Mr. C. O. Vernon and S/L. H. G. Hazelden, respectively chief aerodynamicist and chief test pilot of the company, gave complementary lectures on the requirements and technique of flight-testing new aircraft. Mr. Vernon first detailed the various results it was hoped to obtain in the three phases of testing—functional, handling and performance. He described many of the methods employed to this end.

S/L. Hazelden then followed with some observations from the pilot's point of view, showing some of the special problems in piloting involved in obtaining certain results. The lecturers gave an excellent idea of some of the apparently minor details which had to be dealt with in a normal test programme and of the problems which often arose.

A. F. de Jonquet

IT is with deep regret that *Flight* records the death of Mr. A. F. de Jonquet, a director of Iliffe and Sons, Ltd., and the Louis Cassier Co., Ltd. In his 59th year, he died suddenly at a nursing home at Hove, Sussex, on Thursday, February 17th.

For 33 years Freddie de Jonquet was intimately connected with Great Britain's motor industry, and in recent times his increasing responsibilities had brought him into contact with many other industries.

Educated in England and France, in World War I he was commissioned—from the Inns of Court O.T.C.—in the King's Own Yorkshire Light Infantry and, after serving in France, was seconded to the R.F.C. in 1917.

On demobilization in 1919 he began his business career on a farming journal, and in 1921 he joined the firm of Iliffe and Sons, Ltd., as an advertisement representative for *The Autocar*, in which capacity he soon won the respect of all with whom he came in contact. With his friendly manner (he was, in the words of a colleague, "a man who understood his fellows, and who believed in good fellowship") went a firm and forceful business ability, and in due course the Iliffe advertisement department was placed under his control; later he became a director of Iliffe and Sons, Ltd.—publishers of this journal—and three associated companies.

Mr. de Jonquet is survived by his wife Mary. The funeral took place last Tuesday, February 22nd, and a memorial service is to be held at the Queen's Chapel of the Savoy, Strand, London, W.C.2, at noon on Tuesday, March 1st.

Canada's Production Problem

A REAL, though not immediate, problem facing Canada's Defence Department, according to official pronouncements made in Montreal, is that of keeping open aircraft production-lines. One spokesman has said that, in order to keep the lines in readiness, it may eventually become necessary for the Government to buy aircraft not actually required by the armed forces.

About a year ago it had been planned to spend some $450 million annually for the next seven years on aircraft, but the 1955-56 Estimates, recently tabled in the Canadian Commons, showed an appropriation of only $319 million for R.C.A.F. and R.C.N. aircraft in the coming fiscal year.

There are several reasons for this change, and some factors behind it could not be foreseen a year ago. The Orenda-powered Canadair-built Sabre, for example, as used by the Canadian Air Division in Europe, has proved to be of such quality that the Defence Department has been able to postpone plans to obtain a successor. The all-weather CF-100, moreover, began to leave the assembly lines faster than the R.C.A.F. could put the type into service, and it has been stated that it would be possible to produce sufficient to meet all the needs of the R.C.A.F. in a relatively short time. Once the order was filled, however, the production lines would stand empty waiting for a successor. The ideal situation, of course, would be for CF-100 production to end just as the succeeding CF-105 began to leave the lines. (As already reported in *Flight*, some 1,000 employees have been laid-off by Avro Aircraft as a result of a production "stretch-out.")

AIRBORNE MINISTERS: On the left, Mr. Athol Townley, Australian Minister for Air and Civil Aviation, emerges from the Victor, the controls of which he took over during a flight from the Handley Page airfield; on the right, Mr. John Boyd-Carpenter, Britain's Minister of Transport and Civil Aviation, disembarks after a 35-minute flight in a Bristol Britannia last Saturday.

THE DEFENCE PROGRAMME

—*as it Affects the R.A.F.: Extracts from Last Week's White Paper*

THE *Statement on Defence*, presented to Parliament last week and published* as a White Paper, made the dramatic, if not altogether unexpected, revelation that Great Britain is proceeding with the development and production of "thermo-nuclear weapons"—in other words, the hydrogen bomb.

The White Paper (which should not be confused with another, published on the previous day, and dealing with *The Supply of Military Aircraft*—see p. 233) begins with a statement of defence policy, in which it is pointed out that our problem remains fundamentally a dual one: we have to prepare against the risk of a world war and so prevent it; and it is on the nature of these preparations that the existence of thermo-nuclear weapons has its main effect.

The hydrogen-bomb disclosure is made in the following terms:

"The United States Government have announced that they are proceeding with full-scale production of thermo-nuclear weapons. The Soviet Government are clearly following the same policy; though we cannot tell when they will have thermo-nuclear weapons available for operational use. The United Kingdom also has the ability to produce such weapons. After fully considering all the implications of this step the Government have thought it their duty to proceed with their development and production.

"The power of these weapons is such that accuracy of aim assumes less importance; thus attacks can be delivered by aircraft flying at great speed and at great heights. This greatly increases the difficulty of defence. Moreover, other means of delivery can be foreseen which will, in time, present even greater problems."

After reviewing, in blunt terms, the effects to be expected from a hydrogen-bomb attack, the Statement goes on to say that in the circumstances our immediate duty and policy are clear—to build up our forces, in conjunction with those of our allies, into the most powerful deterrent we can achieve.

Having devoted some space to an examination of the present and potential balance of military power on the Continent, the Statement remarks that we must contribute to the deterrent and to our own defence by building up our own stock of nuclear weapons of all types and by developing the most up-to-date means of delivery. We must, moreover, in making our plans for dealing with aggression against our alliance, not flinch from the necessity to use these weapons—"For in the knowledge of our resolve lies the best hope, and it is a real hope, that it may never be put to the test."

The New Strategy

Meanwhile, continues the Statement, the development of nuclear weapons does not mean that the use of naval and land forces in a major war is now obsolete or outmoded, though their weapons, organization, tactics and training will be profoundly affected. But the Navy is still required to contain and destroy enemy forces at sea so as to allow free movement of supplies and troops and to give both our land and air forces support in their operations. We still need troops on the ground to hold the enemy well to the East in Europe in the vital initial stages of a war. This would give time for the effects of our strategic air offensive to be felt. It would also hold back from the United Kingdom the threat of shorter-range aircraft and ground-to-ground missiles.

At the same time, provision must be made for the defence and continued functioning of the home base. For this purpose R.A.F. Fighter Command must be armed with the most powerful aircraft and weapons we can develop and maintained at a high state of readiness. For civil defence the Services must themselves be trained, local civilian organizations developed, and a link provided between the two. The Government have therefore decided to form a Mobile Defence Corps as part of the Army and R.A.F. reserve forces. In a more detailed note on this decision, in a later part of the report, it is explained that, while general responsibility for the new Corps will rest with the War Office, a certain proportion of the training depots and of the reserve battalions will be manned by the R.A.F. In the event of mobilization the reserve battalions would come under the local operational control of the Army.

Passing on to the rôles of the three Services, the White Paper emphasizes that Britain relies upon the striking power of the Air Force for an immediate and decisive counter-blow; for a major contribution to the defence of this country against air and sea attacks; and for air support to the allied front in Europe.

The control and reporting system in the United Kingdom, the overhaul of which was begun at the outset of the rearmament period, and which is already highly developed, will, it is stated, be further improved.

The expansion of Fighter Command has been completed and its re-equipment is now proceeding: "The balance of the Command will be improved by a further increase in the proportion of all-weather radar-equipped fighters. High priority continues to be given to the development of guided missiles. Orders have been placed for air-to-air guided weapons and progress is being made with the development of other types."

The 2nd Tactical Air Force, the Statement continues, will be maintained at the highest possible efficiency in support of the front in Europe. Improvements will be made in this force so as to increase its fighting capacity. Coastal Command will be strengthened by the addition of some Seamew aircraft for short-range anti-submarine reconnaissance. [This is the only aircraft mentioned by name; see also page 228.]

Of manning arrangements for immediate readiness, the Statement says that aircrew with recent flying experience in operational squadrons are now chosen as immediate reserves. Changes are being made in the organization of the Royal Auxiliary Air Force. Reserve ground personnel are being organized into reserve flights for individual regular stations. They will report to these stations immediately in emergency or on mobilization.

In a section on "research and development," the White Paper devotes a good deal of space to new weapons, offensive and defensive, but little is revealed. "The development and production of manned bombers, which are at present the primary means of delivering nuclear weapons, are proceeding satisfactorily," it says, and goes on: "The manned bomber may eventually be supplemented by the ballistic rocket and we are therefore working on the development of such a rocket as an addition to our deterrent strength. We are also considering methods of defence against this form of attack."

Guided Weapons

The main effort in the development of guided weapons is towards providing defence against bombers flying at high speeds and at great altitudes. Discounting the value of A.A. guns, the Report says that the future air defence system of the United Kingdom will have as its main components the manned fighter and the ground-to-air guided weapon: "The balance between these weapons will vary with new developments, but it is clear that for a long time to come both will be needed to combat the bomber threat. The effectiveness of our manned fighters will be increased by fitting air-to-air guided weapons capable of engaging enemy aircraft at longer ranges and with a much greater certainty of success than is possible with aircraft armed only with cannon. Development . . . has reached an advanced stage."

The surface-to-air guided weapons under development for use from the land and from ships are of greater complexity than air-to-air missiles, and the time required to develop an effective operational weapon system is necessarily longer. Nevertheless, says the Report, good progress has been made and numerous trial firings are taking place both in this country and in Australia.

In a review of the Navy's technical development, the observation is made that the success of recent developments in aircraft carriers and their equipment will make it possible to use at sea heavier and faster fighter and strike aircraft, the latter being capable of carrying atomic bombs.

Among the appendices to the White Paper is an analysis of the active strengths of the three Services. For the R.A.F. the figures (in thousands) are:—

	Apr., 1954 (actual)	Apr., 1955 (estimate)	Apr., 1956 (estimate)
Regular	186.5	181.1	171.9
National Service	69.3	70.2	75.3
Women	9.3	8.0	6.8
Total	265.1	259.3	254.0

Air Force Volunteer Reserve and Auxiliary strengths are also set out in a table:—

	Strength at Jan. 1st, 1954				Strength at Jan. 1st, 1955			
	Normal Volunteers	Volunteers from N.S.	Part-time N.S.	Total	Normal Volunteers	Volunteers from N.S.	Part-time N.S.	Total
R. Aux. A.F.	5,745	763	—	6,508	5,631	774	—	6,405
W.R. Aux. A.F.	2,415	—	—	2,415	2,036	—	—	2,036
R.A.F.V.R. ...	9,913	1,659	—	11,572	8,722	2,181	—	10,903
W.R.A.F.V.R.	523	—	—	523	388	—	—	388
R.A.F. Resv. of Off. (N.S.) & Class H Resv.	—	—	124,364	124,364	—	—	136,314	136,314

*Cmd. 9391, Her Majesty's Stationery Office; price 1s.

HERE AND THERE

Coastal Seamew

THE Short Seamew light anti-submarine aircraft which, as announced in the *White Paper on Defence*, is to go into service with the Royal Air Force, will be used by Coastal Command for short-range, in-shore operations. The makers say that the Seamew can operate from such makeshift "runways" as golf fairways or flat beaches. The fitting of oversize wheels makes it possible to fly from soft ground.

"Korea Workhorse"

ON Friday last the U.S. Navy took delivery of the 2,500th Douglas Skyraider. These aircraft have been in continuous production for ten years.

Yet More Neptunes

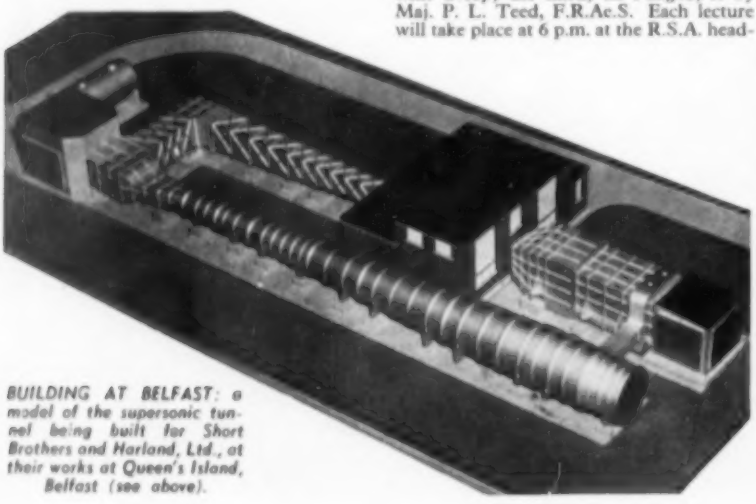
AT a cost of $10½ million, the U.S. Navy has ordered 46 Lockheed P2V-7 Neptunes. This sub-type is equipped with two underwing Westinghouse J34 booster turbojets, in addition to the Wright Turbo-Compound piston engines.

Australian Airfield Programme

COMPLETION by June next of a second runway at Amberley R.A.A.F. Station will mark the first of three major stages in Queensland's £5m military and civil airfield programme. The Amberley project will cost a total of £1,700,000, a sum slightly less than that allocated for a runway at Garbutt R.A.A.F. Station, Townsville. The third project is the construction of an 8,000ft runway at Brisbane's Eagle Farm Civil airport, at a cost of £1½m.

Belfast Tunnel

DRIVEN by three Rolls-Royce Nene 101s, the Short and Harland wind tunnel illustrated below will operate at atmospheric stagnation pressure and at a stagnation temperature of up to 100 deg C (to prevent condensation) with a Mach number of 1.2 in the 2½ft-square working section. The principal contractors are Shorts' associated —and neighbouring—firm of Harland and Wolff; the tunnel should be at work later this year.



BUILDING AT BELFAST: a model of the supersonic tunnel being built for Short Brothers and Harland, Ltd., at their works at Queen's Island, Belfast (see above).

ROTOR - DRONE: This Kaman HTK-1, modified for radio control from the ground, has completed over 100 hours, including landings and take-offs, under monitoring. A safety pilot is carried in case of a failure.

C.A.I. Officers

AT elections held by the Vancouver branch of the recently formed Canadian Aeronautical Institute the following executives were elected: H. D. Cameron, Canadian Pacific Air Lines (chairman), E. N. Atkey, Bristol Aero Engines (Western) (vice-chairman), R. J. McWilliams, Canadian Pacific Air Lines (secretary/treasurer), T. W. Siers, Canadian Pacific Air Lines, and J. Bertalino, Department of Transport (councillors). The two last-named represent the branch on the council of the Institute.

Sir James Barnes in Australia

BRITAIN'S Permanent Under-Secretary of State for Air, Sir James Barnes, reached Sydney by air from London on February 16th. He will spend a fortnight in Australia looking over R.A.A.F. establishments and meeting Government officials and will visit the Woomera rocket range. After his stay in Australia he will continue with a programme of visiting—on air business—a number of other Commonwealth countries.

R.S.A. Lectures on Metals

WITH *The Mechanical Properties of Metals* as their subject, three Cantor lectures are to be presented before the Royal Society of Arts on March 14th, 21st and 28th. The first, by Prof. Hugh Ford, D.Sc., Ph.D., is titled *Tensile Properties;* the second is by Prof. E. N. da C. Andrade, D.Sc., Ph.D., LL.D., F.R.S., and deals with *Creep;* the third, on *Fatigue*, is by Maj. P. L. Teed, F.R.Ae.S. Each lecture will take place at 6 p.m. at the R.S.A. headquarters in John Adam Street, Adelphi, London, W.C.2, and applications for tickets should be made to the secretary at that address.

What's My Line?

EQUIPMENT of some U.S. domestic airliners with television may follow recent experiments. Mr. William Paley, chairman of Columbia Broadcasting System, recently saw a demonstration in which reception was reported as perfect even at 330 miles from the coast.

For Motor Cycle Buyers

THE next issue of our associated journal *The Motor Cycle* is the annual Spring Number and Buyers Guide, appearing on March 3rd. It will contain specifications and prices of all motor cycles, motor scooters, three-wheelers and sidecars on the British market.

Air Race Date Changed

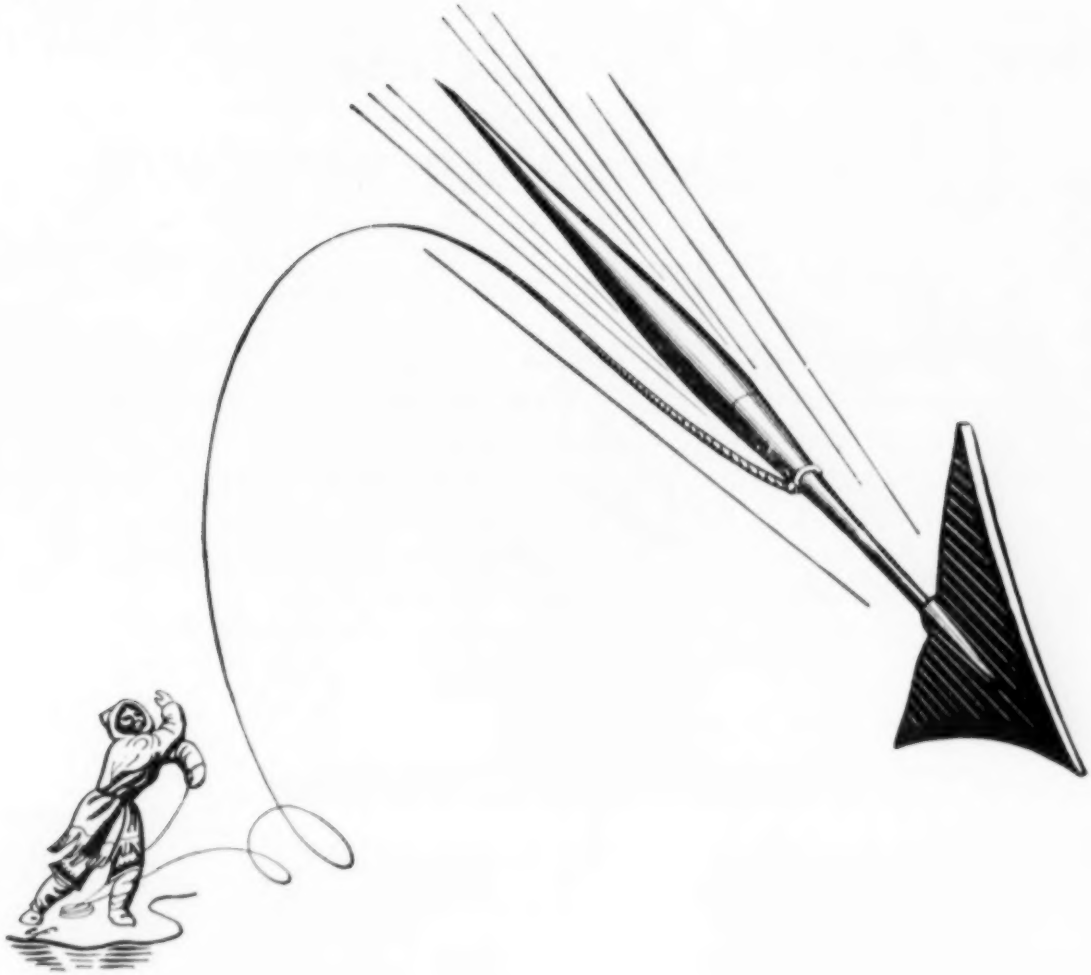
SINCE the Royal Aero Club's original announcement, last month, of details of the National Air Races, the date of the second meeting, at Yeadon, has been changed from Whit-Saturday, May 28th, to Whit-Monday, the 30th. The event will be held in conjunction with the S.S.A.F.A. air display on that day.

"Ever-ready" R.A.A.F. Squadrons

THE Australian Chief of Air Staff, Air Marshal Sir John McAuley, has stated in Canberra that the R.A.A.F. has plans for building up a force of four jet squadrons ready for use anywhere in the world. There will be two Sabre squadrons and two of Canberras, to be ready for operation before eighteen months are out.

Airlift Trophy

A GOLD cup presented by an anonymous donor to commemorate the part played by the R.A.F. in the Berlin airlift has been awarded to No. 99 Sqn. Transport Command (S/L. R. F. B. Pole). The trophy is to be awarded annually to a Transport Command squadron which participated in the airlift, and will recognize general efficiency, flying safety, courtesy and aircrew smartness. No. 99 becomes the first winner of the award, which will be presented at Lyneham, Wilts, at a parade next month.



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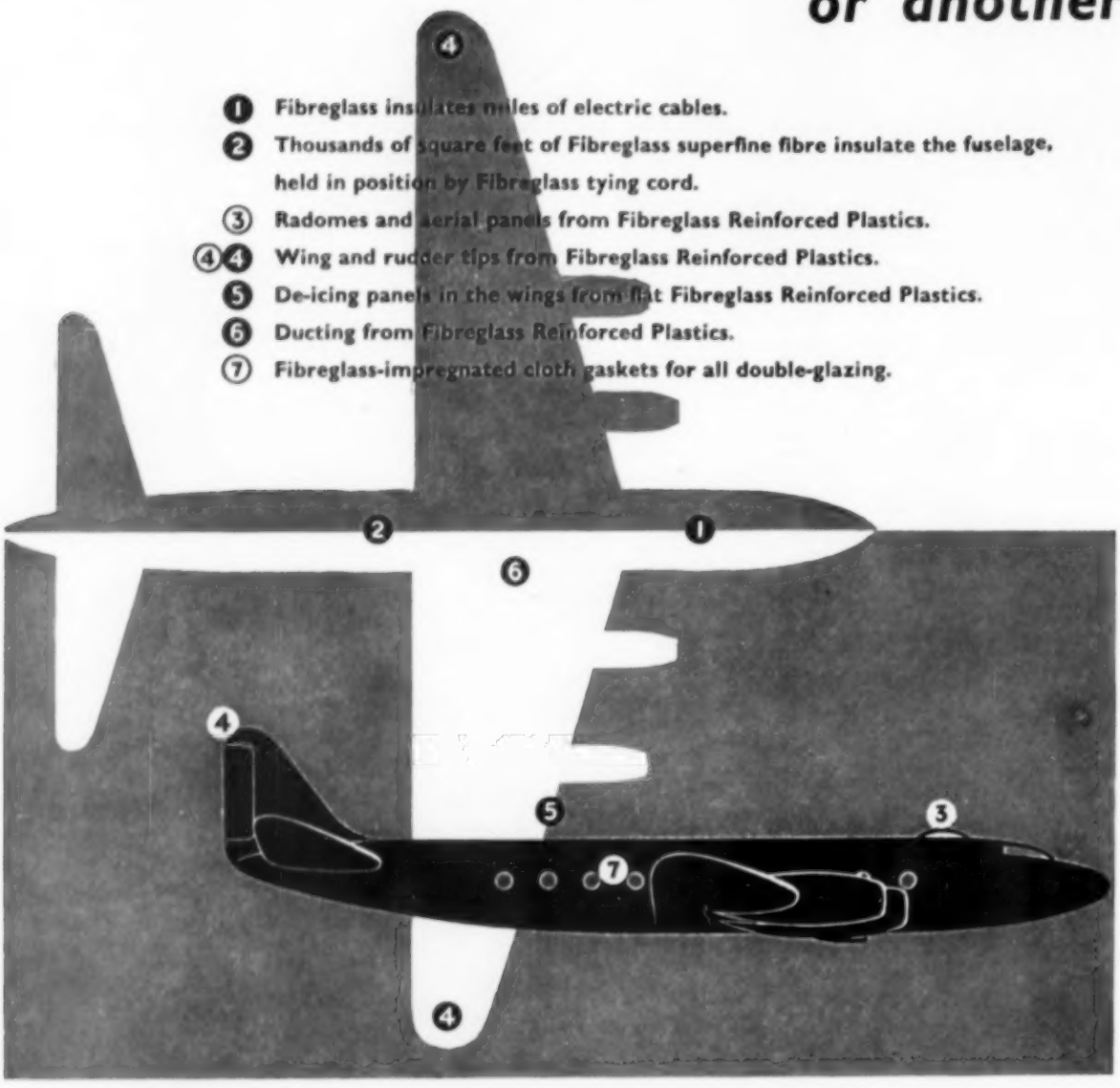
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WIND TUNNELS, MISCELLANEOUS

First Impressions of N.A.E., Bedford: Farnborough Facilities Reviewed

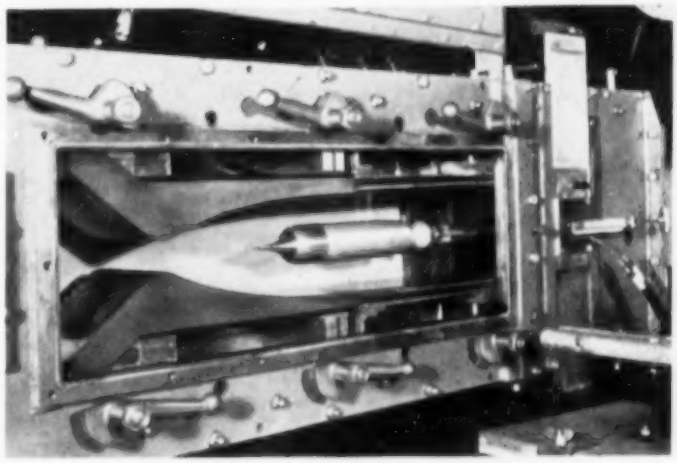
"EVER since the days of the Wright brothers, the wind tunnel has been one of the main tools available for helping aircraft designers and aerodynamic research workers in their work." This Ministry of Supply declaration —and few would disagree with it—introduced an announcement made on the occasion of a recent Press visit to R.A.E., Farnborough, and the National Aeronautical Establishment, Bedford.

Such a visit was extremely welcome, for the latest M.o.S. tunnels, however valuable for helping designers and research workers, had certainly not been previously available for inspection by anyone not directly concerned with them. About Bedford, in particular, much had been rumoured but little was accurately known. And even if the R.A.E. Aerodynamics Department did keep quiet about some of their most advanced ideas and specialized equipment, one was able to obtain a good overall picture of the present range of major national wind-tunnel facilities.

Most *Flight* readers will be aware that wind tunnels today are used at every stage of the development of an aircraft: in building up background knowledge of airflow behaviour on which new designs are based, trying out new ideas, checking the aerodynamic performance of the completed design and investigating any undesirable characteristics found by the test pilot.

The sort of information that a wind tunnel can give is wanted before the design can start, and so tunnel performance must keep ahead of that of the aircraft. In 1942, when Wellingtons and Spitfires were flying at 200 to 300 m.p.h. (up to Mach 0.4), British wind tunnels were working up to Mach numbers of about 0.8. Later, in the early days of Meteors and Vampires, small-scale tunnels capable of between Mach 2 and 3 were brought into action, and were followed in recent years by larger-scale tunnels in this speed range. In the meantime, small-scale equipment for Mach numbers up to about 4 or 5 have been introduced and corresponding large-scale plant is planned. At present, tunnels are being built capable of speeds up to about Mach 9, which is the limit to which conventional wind tunnels can go. For higher speeds, experimental techniques are being developed which are suitable for Mach numbers betwen 10 and 20.

During the last 15 years the wind tunnel has grown from a relatively simple (though bulky) affair, costing a few thousand pounds and absorbing a few hundred horsepower, into a major engineering effort with a cost measured in millions of pounds and using up to 100,000 h.p. Similarly, the models have changed from carved wood to solid steel; and the need to obtain the maximum output from such large investments has led to developments in measuring equipment, from simple balances and manometers to automatic recording equipment with electric typewriters, automatic curve-plotting, and machinery producing punched cards ready to feed into computing machinery to provide corrected data.

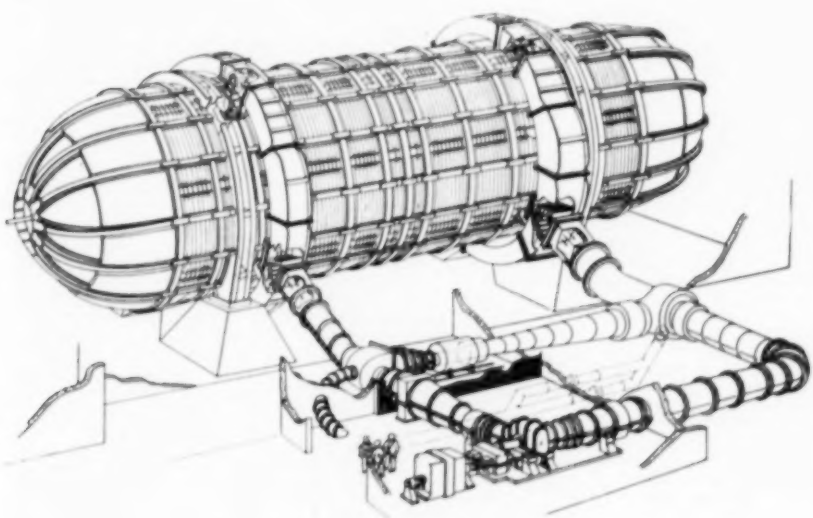


The working section of one of the supersonic tunnels of Farnborough's "high-altitude test plant." The sting-mounted model is of the engine air intake of a supersonic aircraft.

If there were no limitations imposed by finance or by the engineering facts of life, it would clearly be ideal for a wind tunnel to be capable of reproducing exactly the airflow over the full-scale aircraft in flight. This would not necessarily mean testing the full-scale aircraft at the correct wind speed and air pressure, for full-scale conditions can be produced by testing a smaller model at high air-pressures. In general, however, the limited strength of models prevents the use of very high-pressure tunnels at high airspeeds. Accepting this limitation on tunnel pressure, the representation of full-scale airflow around even moderate-sized aircraft in supersonic tunnels would involve something like 1,000,000 h.p.—clearly impractical from both engineering and financial viewpoints.

Fortunately, satisfactory results can be obtained by the use of smaller models and lower pressures than are required for perfect representation of the full-scale flow, provided the model scale and air pressure are not too low. A satisfactory compromise between the full-scale ideal and the small tunnel can be reached, so that the financial and engineering problems are not outrageous and reliable tests are possible. Such a compromise leads to tunnels such as the 8ft × 8ft supersonic tunnel at Bedford, which has a Mach number range up to 2.7 and uses some 80,000 h.p. For higher speeds up to Mach 5, a tunnel about half this size, using 50,000 or 60,000 h.p., would seem appropriate. The cost of these major engineering undertakings may be several million pounds.

In the low-speed field, the power required is small (about 20-30 h.p. per square foot of working-section area) and the main problems are encountered in the construction of the actual air circuit. The aerodynamic problem is to achieve an airstream of extremely high uniformity and low turbulence. This is ensured by the use of the characteristic long tapering diffusers, to avoid flow separation, and the very large settling chambers and gauze screens placed upstream of the working section. Flow



At Farnborough, the 10ft × 7ft "high-speed tunnel" is being transformed into an 8ft × 6ft transonic tunnel. Across the ducting to and from the auxiliary compressor a small transonic "by-pass tunnel" is being installed.

WIND TUNNELS, MISCELLANEOUS . . .

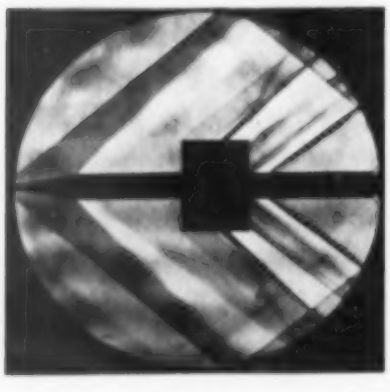
uniformity of one part in 1,000 and a turbulence level of one part in 10,000 have been obtained in the best modern low-speed tunnels, such as the 8ft × 12ft tunnel at Farnborough and the 13ft × 9ft tunnel at Bedford. Here the sound-waves from the turbulent boundary-layer on the tunnel walls are the main disturbance in the airstream, and refinement in low-speed tunnel design can go little further. The vertical spinning tunnel is one specialized type of low-speed tunnel.

In high-supersonic and transonic tunnels, the main technical problem is associated with tunnel-choking near the speed of sound. Methods of avoiding difficulties caused by the changing nature of the airflow at about Mach 1 have now been developed, so that testing over the whole speed range through the speed of sound is now possible with reasonable-sized models. Such a transonic working-section has been in use, as required, in the 3ft × 3ft supersonic tunnel at Bedford for some time past, while the 10ft × 7ft high subsonic tunnel at Farnborough is being converted into a small-scale tunnel of transonic type.

In the supersonic speed range many small research tunnels covering the speed range up to Mach numbers of between 4 and 5 have been in use for many years. These are employed to support the work of medium-sized tunnels up to Mach 2, such as the 1½ft × 1½ft equipment at Farnborough, and the 3ft × 3ft installation at Bedford; and these in turn will back up the large 8ft × 8ft supersonic tunnel at Bedford. The technical problems of tunnels in this speed range include the relatively larger importance of the compressor, the added complication of air-drying—which becomes necessary in supersonic tunnels—the smooth finish required in the inside of the working section, and the difficulties of producing uniform airstreams at supersonic speeds.

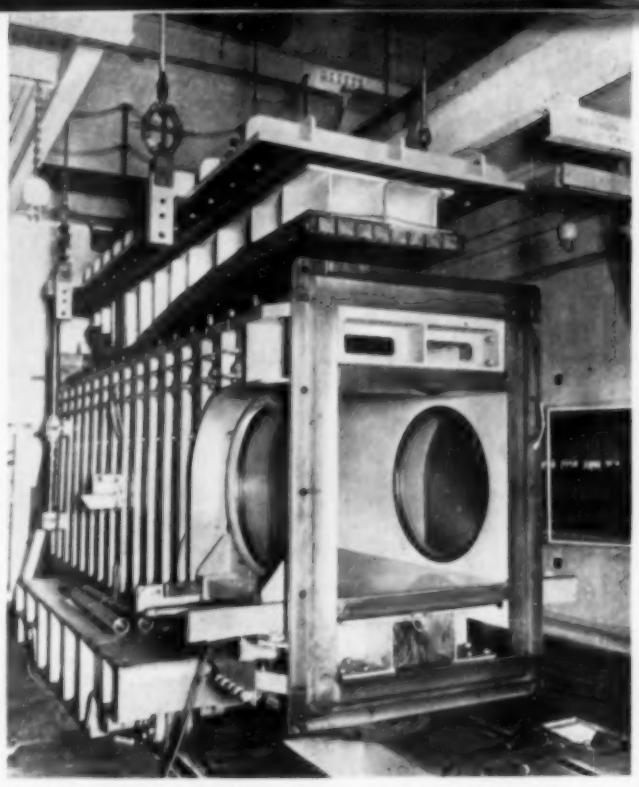
To produce this uniform supersonic airstream, a carefully shaped wall upstream of the working section is required, and a different contour is required for each Mach number. The conventional method of arranging this has been to use interchangeable, accurately made liners or nozzle blocks to give a range of speeds; an important new development seen on the large supersonic tunnel at N.A.E. is the employment of flexible steel plates supported on hydraulic jacks which can be automatically adjusted to give the exact wall-shape required for any selected Mach number.

One obvious method of saving power, applicable at least to the small type of tunnel, is to store the energy from a relatively small pumping plant in a vacuum vessel and to use the stored energy to run a tunnel for, say, 10 or 20 seconds every 5 or 10 minutes. There are limitations to the type of measurement that can effectively be made in such tunnels, but they can be a cheap and useful adjunct to the conventional type. In one group of such "intermittent" tunnels (associated with the 1½ft × 1½ft supersonic equipment) at Farnborough, the speed range covered is up to Mach 4. At present most large-scale installations cover a range up to about Mach 2.5, leaving the higher speed-range to smaller tunnels. Design work has been going on for some time, however, on large-scale plant to fill the range from Mach 2 to 4.5.



A typical Schlieren photograph, showing the shock-wave pattern around a model mounted in a supersonic airflow.

The choice of 4.5 to 5 as the upper limit for supersonic tunnels represents a natural limit set by the liquefaction of the air in the tunnel. As the air expands through a nozzle at these very high Mach numbers it becomes cold and, starting from normal room temperature, by the time a Mach number of 4 is reached, the air will be so cold (about 400 deg F. of frost) that it liquefies and the tunnel becomes filled with a mixture of air and small droplets of liquid air, making testing impossible. The only answer to this problem is to heat the tunnel air, and a new tunnel is being designed in which the air is heated to 600 deg C. by passing it over red-hot plates and then through a quartz working-section at speeds up to Mach 8 or 9. This sort of speed does represent the limit of the conventional type of wind tunnel, and for still higher speeds alternative experimental techniques such as the "shock-tube" are being investigated.



For rapid change of liners, the working section of the 3ft × 3ft tunnel at Bedford moves out along rails and the shaped liner is raised and replaced. Tunnel walls and floor are flat.

R.A.E. TUNNELS.—At Farnborough, we first visited the **"High-altitude Test Plant" Supersonic Laboratory**—a group of the establishment's older supersonic tunnels. After the end of the last war, R.A.E. research on reciprocating engines was abandoned, and the plant previously used for high-altitude performance testing of engine components was adapted to power six small supersonic tunnels.

This test plant consisted of 18 water-sealed vacuum pumps and three centrifugal exhausters: also available were two refrigerating engines, and an activated-alumina drier for reducing the absolute humidity of tunnel air to less than 0.02 per cent. Further equipment, more recently installed, includes two seven-stage centrifugal compressors and seven centrifugal superchargers, which boost the air pressure to five atmospheres before it reaches the tunnels. Maximum power used by any one tunnel is over 15,000 h.p.

The working sections of the six tunnels range from 5in to 10in square, and they were designed to cover Mach numbers of 1.3 to 4.8. Four of the six are used to study basic problems of supersonic flow, such as gas-turbine and ramjet air-intake design and wing/body interference effects, prior to further investigations on particular points in larger and more representative tunnels. On the occasion of our visit, a 5½in × 5½in tunnel, running at M = 3.27, was being used for force and pressure measurements and shock-wave-pattern observation of an engine air intake for a supersonic aircraft.

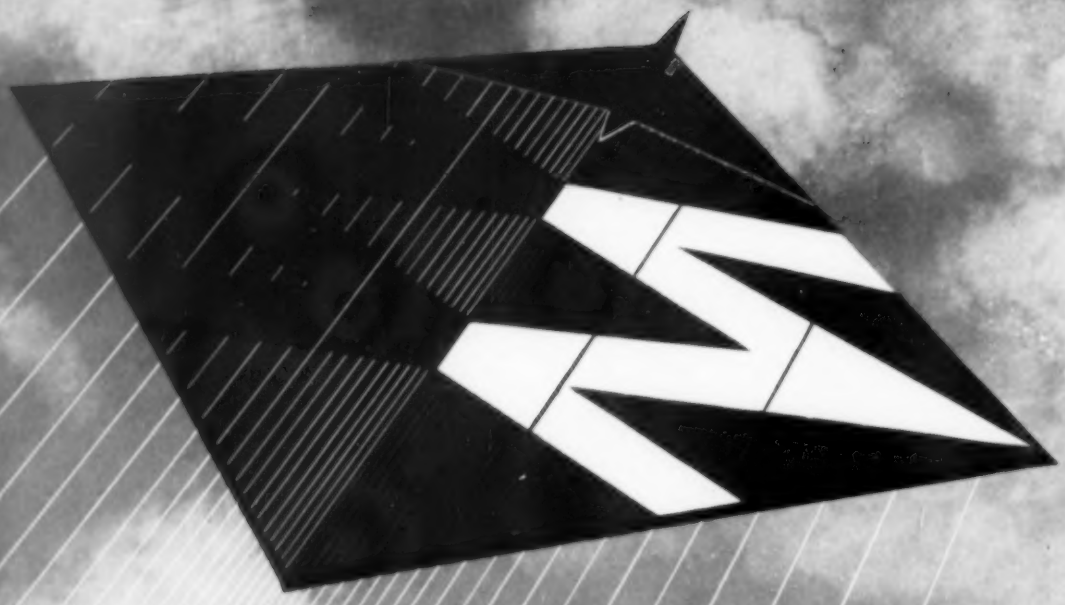
Another tunnel of the group was specially strengthened to take the maximum stagnation pressure of five atmospheres (obtainable at Mach numbers above 3.0); in the working section of another, a tilted flat plate was used to obtain lower speeds in the transonic-flow region.

Each tunnel has been adapted to investigations into a particular aspect of supersonic flight in order to avoid long delays in changing different test rigs. Specialized tunnels are used for investigations into boundary-layer flow characteristics, aerodynamic heating problems, and pressure variations in the hot gas stream from an engine, as well as air-intake design.

The 8ft × 6ft Transonic Tunnel at R.A.E. is to be a modified and improved form of the well known 10ft × 7ft "high-speed tunnel" which has been operating since 1942. Work is at present continuing on this modification, and is expected to be complete by the autumn of this year.

In its new form, the main-fan power is being increased from 4,000 h.p. to 12,000 h.p., enabling higher pressures and hence increased Reynolds Numbers to be achieved. An auxiliary compressor of 8,000 h.p. and a transonic working section have also

An impression of the final Test as seen from a T.A.A. Viscount



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been added in order to increase the higher limit of the Mach number range from 0.95 to about 1.2. In the transonic working section a proportion of circulating air is extracted by the auxiliary compressor and returned to circuit downstream of the fan.

A special building has been erected to house the new 8,000 h.p. compressor, together with the ducting to and from the tunnel, an air cooler, and control apparatus. When complete, the tunnel will prove a most useful tool for the testing of models of aircraft and for associated research on the peculiar problems of performance and control in transonic flight. The Mach number range will be 0.15 to 1.2, and Reynolds Numbers in high-speed and low-speed tests, 3.5×10^6 and 0.6 to 5.0×10^6 per ft wing chord respectively.

To make economical extra use of the 8,000 h.p. auxiliary compressor, a **2ft × 1½ft Transonic "By-pass Tunnel"** is being installed "in parallel" in a cross-pipe between the connecting ducts (see diagram). An arrangement of isolating valves enables the compressor to be used as the main drive or air circulator for the by-pass tunnel when the 8ft × 6ft is not in use.

This by-pass tunnel is designed to run at speeds up to Mach 1.5. It will be useful for preliminary work on aircraft designs later to be tested in the 8ft × 6ft tunnel, as well as being a valuable research tunnel in its own right, in connection with the design of both aircraft and transonic tunnels themselves. The Reynolds number attainable at high speed is 4.0×10^6 per ft chord.

The **11½ft × 8½ft Low-speed Tunnel** was the next to be visited. This has been in operation since 1943 and, being used in cases where the airstream can be regarded as virtually incompressible, is limited to a maximum speed of 400 ft/sec. At this speed, 4,000 h.p. is required to drive it, and cold brine is circulated through the metal turning vanes for cooling. Most of the tests, all concerned with low-speed effects, are made at about 200 ft/sec.

The tunnel is of single closed-circuit type, with a 6.3 : 1 contraction ratio, and is fitted with three fine-mesh screens and a honeycomb in its 24ft-square maximum section. Typical models used have spans of about 7ft: at the time of our visit, aileron hinge-moments were being measured, at various angles of incidence and tab settings on a floor-mounted 5ft semi-span swept wing—which, we were told, was *not* typical.

Lift, drag, and pitching moments can be measured on the overhead balance, while a six-component balance (side forces, rolling and yawing moments in addition to these three) is fitted below the working section. A point of mechanical interest about this latter balance is that all moving parts of the balance frames slide freely, relative to one another, on thin films of compressed air.

A typical medium-size supersonic installation is the **1½ft × 1½ft Supersonic Tunnel,** driven by a 7,000 h.p. synchronous motor coupled to a seven-stage axial-flow compressor. In this unit, in the words of Mr. L. F. Nicholson, head of R.A.E.'s aerodynamics department, the establishment has "really tried to get the most out of the tunnel"—particularly by the use of highly refined and automatic instrumentation.

A characteristic of the compressor is that the rotor-blade pitch setting can be varied, to control the pressure ratio, while the rotor itself is running. The Mach number range of the tunnel is from 1.4 to 2.2, and the stagnation pressure can be varied between 0.1 and 2.8 atmospheres.

As mentioned, the recording of data during a tunnel run is fully automatic. Aerodynamic readings from six self-balancing potentiometers are taken, on the pressing of a button, by a scanning device, and are simultaneously recorded on a sheet of paper by an electric typewriter and also on punched cards. Three sets of data per minute can be recorded during a run, which may take up to two hours. The punched cards are fed to an automatic computing machine, which produces the final coefficients required for the analysis of results. The object of all this attention, during our brief passage through the observation room, was a suitably anonymous-looking cylindrical object with a pointed nose and cruciform fins.

Our final call at Farnborough was at the **Intermittent Tunnel Plant**, comprising four small-section units. These tunnels are operated by connecting them between steel vessels which can be evacuated and a storage vessel (made of balloon fabric) containing dry air. The steel tanks are evacuated by a set of pumps of 300 h.p. which pump the air into the storage balloon, where it is dried, operation being controlled by a quick-acting valve.

In the largest of these tunnels (15in × 16in) a 20-second run can be made every 20 minutes, or shorter runs more frequently, and the highest useful Mach number obtainable is 4.5. This type of tunnel is particularly suitable for tests involving frequent changes of a model configuration (such as measurements of loads on control surfaces), since starting and stopping procedure is simple.

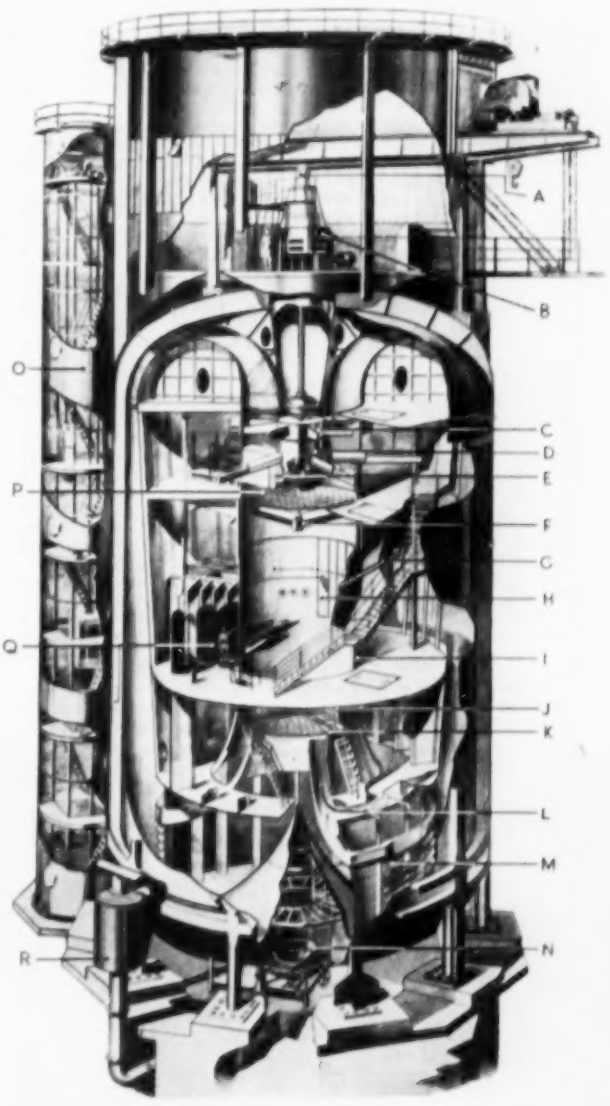
N.A.E. FACILITIES.—A long-awaited first glimpse of the National Aeronautical Establishment came the following day, as we were conveyed along the specially built road from Clapham, near Bedford. Although much building work is still in progress, the site is spaciously laid out and the modern appearance of the various functional blocks is attractive as well as efficient.

N.A.E. is at present considered as one of the R.A.E.'s outstations, and the wind-tunnel facilities there come under Farnborough's aerodynamics department. The aerodynamic work of the two places therefore forms one complete programme, with the larger tunnels mainly situated at the newer establishment.

The first installation visited was the **3ft × 3ft Transonic and Supersonic Tunnel,** capable of Mach numbers up to 2.0, which has been in use for the past five years. While the large transonic tunnel at Farnborough is not in use this tunnel takes the main load of transonic work.

The tunnel circuit is a steel shell with a maximum cross-section 19ft square, and is designed for working pressures from $\frac{1}{10}$th to 2 atmospheres. Separate liners (forming the working-section roof) are used to obtain the required Mach numbers; these are made of polished teak on steel frames and, when not in use, can be kept in a convenient storage bay above the working section. Efficient handling and clamping arrangements are provided, and it is claimed that liner changes take only 15 minutes.

The air is circulated by means of two large centrifugal compressors connected in series and driven by D.C. motors, each providing 6,000 h.p. (or 8,000 h.p. for short periods). These motors (the complete power section was originally used in a wind-tunnel at the German research station at Volkenrode) are supplied from grid-controlled mercury-arc rectifiers for speed control. Auxiliary plant is provided for drying the tunnel air, controlling its pressure and keeping its temperature down to about 40 deg C.



Cut-away view of the vertical spinning tunnel at N.A.E., Bedford.
(A) hydraulic ram, (B) motor, (C) V.P. fan, (D) nose fairing, (E) access to nose fairing, (F) removable support for rolling balance, (G) periscope, (H) working-section windows, (I) Dunlopillo mattress, (J) catch net, (K) model-retrieving platform, (L) by-pass duct, (M) screens and turning vanes, (N) bottom door, (O) lift shaft, (P) catch net, (Q) observation and launching chambers, (R) blow-off silencer.

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In the spacious and well-laid-out observation room, steps have again been taken towards a high degree of automatic instrumentation. Pressure-distribution readings from a bank of 50 automatic manometer dials are photographically recorded, sting-mounted electric strain-gauges and recording equipment are used to measure and record the aerodynamic forces and Schlieren optical apparatus enables full observation of the shock-wave pattern to be made.

A test run at M=1.6 with a straight stub-wing model was taking place as we entered. The Schlieren screen here was in Technicolor; blue compression shock-waves and yellow expansion waves produced a complex pattern around the model silhouette.

The strange device illustrated on page 231, and known as the **Vertical Spinning Tunnel,** was next on our list. Its main purpose is to enable the behaviour of free models in spinning flight to be observed, and particularly to investigate methods of recovery from a spin. The installation is almost complete and will begin operation in a few weeks' time.

The tunnel consists of a vertical steel pressure-shell, some 80ft high and 45ft in diameter, with a fan and internal ducting to provide an airflow up the central working section and down the outer annular return circuit. The working section is 15ft in diameter and can accommodate models of up to about 3ft wing span (exterior photograph, p. 192 in last week's issue).

The tunnel can be pressurized to 45 lb/sq in (equivalent to 4 atmospheres), and arrangements are provided whereby the model can be launched into the airstream and brought back to the launching chamber by remote control. The model can be viewed through a periscope, and television equipment is also to be fitted.

The airflow is produced by a fan driven by a 1,500 h.p. electric motor, and sensitive speed control is provided by hydraulic adjustment of the pitch of the fan blades. The operator adjusts the upward airspeed until it equals the rate of descent of the spinning model, so that the model remains at approximately the same height and can be held under continuous observation. Maximum airspeed is 60 m.p.h. at full pressure and 95 m.p.h. at atmospheric pressure.

Apart from the free-spinning tests the tunnel can also be used for aerodynamic force measurements on a model mounted on a rotating support. Measurements thus made are complementary to the qualitative results obtained in the free-flight tests.

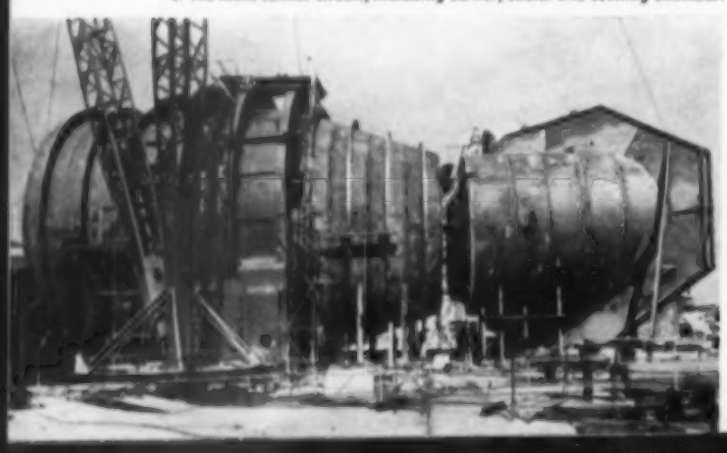
The 4,000 h.p. compressor used to pressurize the spinning tunnel also provides a common air supply for the four **Small Supersonic Tunnels** forming N.A.E.'s high-speed laboratory. This supply enables tunnels with working sections up to about 9in square to be run at Mach numbers up to 3.5. As Mr. M. B. Morgan (Deputy Director of the R.A.E.) put it, "These are really tools for the long-haired boys"—and they are used mainly for pure research along advanced lines.

An auxiliary pump is used to evacuate the tunnel circuit or to pressurize up to four atmospheres, and a conventional system of air driers and coolers is provided. Three tunnels have so far been in operation, a 4in-square and a 5½in-square working section for tests on tunnel designs and an 8in×9in tunnel for general use.

The **Low-speed Tunnel** at Bedford is a massive concrete structure having a working section of 13ft×9ft and being capable of speeds up to 300 ft/sec. Although the main function of N.A.E. is to obtain design information for high-speed aircraft, knowledge of the performance of those aircraft at low speeds (and, in particular, knowledge of control effectiveness during landing and take-off) is also essential. The low-speed tunnel is used, too, for more fundamental investigations into aerodynamic theory.

The air is circulated around the closed circuit by a six-bladed 30ft-diameter fan driven by an electric motor of 15 h.p. To ensure a low turbulence-level, a large settling chamber measuring 46ft across is included and is fitted with fine-mesh wire screens.

The mammoth scale of engineering involved in the 8ft-square supersonic tunnel at N.A.E.; taken during construction, this photograph shows part of the main tunnel circuit, including corner, cooler and settling chamber.



The wooden working section is suitable for tests on models with wing spans up to 10ft and the usual measuring equipment is provided, including an automatic six-component overhead balance for measuring aerodynamic forces, and manometers for obtaining detailed pressure-distributions. The prototype of an automatic recording manometer, in which the levels of 20 tubes are registered by an electric typewriter, was in use on the occasion of our visit. A further four of these multi-tube installations are to be fitted.

Auxiliary plant for the tunnel includes compressors and evacuators for producing flow for boundary-layer control on models, and also electric equipment for supplying small motors on the model, to drive airscrews or a fan producing jet-flow.

Without doubt, the most interesting project seen at N.A.E. was the huge **8ft×8ft Supersonic Tunnel** now approaching completion, in which models up to 6ft span will be tested up to Mach numbers of 2.7. An idea of the scale of engineering involved in this plant can be obtained from the accompanying photograph, but only by actually seeing the whole complicated web of heavy machinery (the installation includes its own power station) can one appreciate fully the size and extent of this one piece of equipment.

The tunnel is of the variable-density type, and the air pressure can be varied from 1/10th to 4 atmospheres. Scale effect is minimized, as in other tunnels, by using as high an air pressure as possible, but in practice the working value is limited by considerations of model strength (particularly during the unsteady-flow conditions when starting up or stopping the tunnel) and, at the higher speeds, by the amount of compressor power available.

The tunnel structure is a steel shell weighing some 5,000 tons and with a maximum diameter of 47ft. Flexible joints and supports are provided to permit thermal expansion, and massive concrete foundations were required to carry the thrusts due to the internal air pressure.

The air is circulated by a large ten-stage axial-flow compressor which absorbs 80,000 h.p. Four stages are always in circuit, and are adequate for subsonic and low supersonic speeds, while the remaining six are brought in for the higher supersonic velocities. Of this 80,000 h.p., 68,000 h.p. is provided by a large A.C. motor, and the remainder by a pair of D.C. motors for starting and for precise speed control. To attain maximum flexibility, an electrical generating station, to be powered by two 20 MW gas-turbine sets, is being built on the site. When complete, it will supply the 8ft×8ft and also other tunnels.

The most intriguing feature of this altogether intriguing tunnel lies in the method of changing the tunnel-wall contour to obtain the required speed-range. Instead of having changeable liners of various shapes, two of the tunnel walls will themselves be continuously variable in contour. They will consist of flexible steel plates, each 62ft long, 8ft wide and one inch thick.

Thirty pairs of hydraulically operated screw-jacks, approximately equally spaced, bend the flexible plates to the aerodynamic shape required. Each jack has its movement controlled by an electro-mechanical device which converts electrical impulses from a telegraph tape-reader into small linear movements which open the hydraulic valve. The position of each jack for the whole Mach-number range of the tunnel is therefore programmed as a series of holes on a length of paper tape. The accuracy with which the required shape can be maintained is indicated by the screw-jack movement per hole in the punched tape; it is 0.0025in, or, in regions where the movement is critical, only 0.00125in.

Downstream of the working section of the 8ft×8ft tunnel are two diffusers; the first a variable-geometry supersonic diffuser with movable side walls, enabling the shock-wave system to be set up as efficiently as possible (in conjunction with a particular position of the flexible walls); and the second a fixed subsonic diffuser. At present the supersonic diffuser is mounted on a wheeled base: this is for installation only, however, and the shape of this section will normally be remotely controlled.

The tunnel's auxiliary equipment includes compressor and evacuator plant (totalling over 8,000 h.p.), silica-gel drying plant, and a cooling system which includes a large tubular cooler in the tunnel circuit which reduces the air temperature from 150 deg C after leaving the compressor to the normal working temperature of 40 deg C.

N.A.E.'s 8ft×8ft installation is an extreme example of what had become obvious in almost every tunnel seen on our two-day programme—the immense amount of space required by the equipment needed to blow, compress, evacuate, cool and dry the air, compared with the size of the tunnel itself. The working sections, where most attention normally focuses, and in some cases the whole tunnel circuit, were seen to be dwarfed by the sheer weight and volume of plain heavy bread-and-butter engineering required to provide power and auxiliary processes.

With these big N.A.E. tunnels, Sir Arnold Hall had pointed out at the start of our visit, came big constructional problems, which had been solved only by effective co-operation between the Ministry of Supply, Ministry of Works and the various contractors. Certainly the resulting facilities, coupled with those at Farnborough, are unsurpassed at any other establishment.

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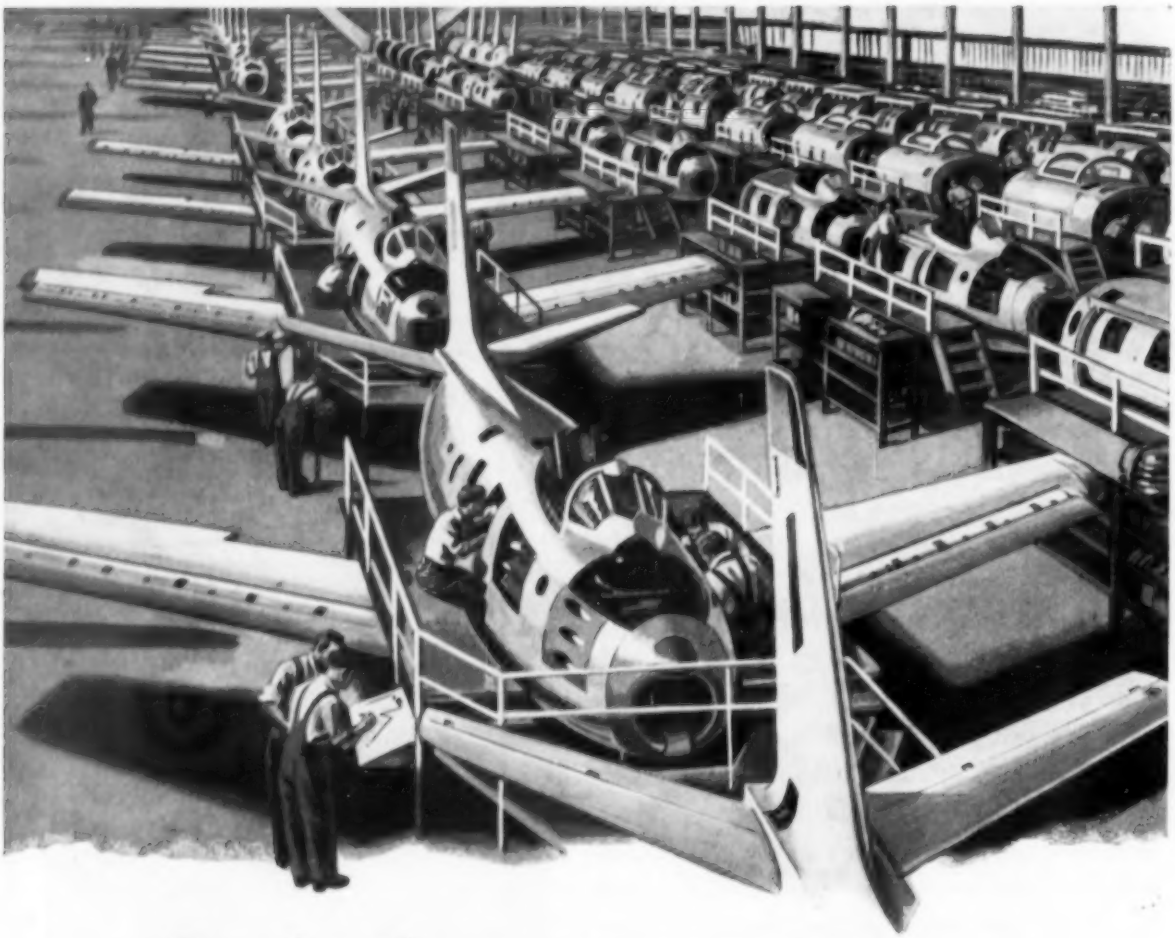

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The Government White Paper Summarized

THE Government White Paper on *The Supply of Military Aircraft*, published* last week, opens with a historical review of the aircraft position at the end of the war, when both the Royal Navy and Royal Air Force were equipped almost entirely with piston-engined aircraft.

As another war in the near future seemed unlikely it was decided not to take a major step in re-equipment until about 1957, and meanwhile the Services stated their requirements for the aircraft and armament which they thought would be required by that time. These requirements led to the initiation of the Vulcan and Victor designs in 1947 and that of a swept-wing day fighter and a two-seat all-weather fighter in 1948. "Although," says the White Paper, "a swept-wing Nene-engined aircraft comparable in time and performance with the Sabre and the Mig could have been developed, it was decided not to proceed with an interim fighter of this type."

In a section on research it is stated that, in the light of the knowledge then available, the risks of attempting supersonic flight in manned aircraft were considered unacceptable and that it was decided that research should at first be conducted by means of air-launched models. "It is easy to be wise after the event," says the White Paper, "but it is clear now that this decision considerably delayed the progress of aeronautical research in the U.K." Economic factors, it is explained, also hampered research. Nevertheless, various research aircraft were ordered.

The Paper then goes on to review development of specific aircraft. Mention is made of the successful development of the Canberra, first conceived late in 1944; of such "insurance" types of aircraft as the Short S.A.4; of Vampires; of advanced marks of the Meteor; and of the development of the Venom. It continues:—

"At the same time the question of ordering an operational version of one of the two swept-wing single-seat research aircraft was considered. It was concluded that this could not be done in either case without delaying other projects of a more advanced nature. In 1949 this was considered again but in view of the financial crisis and consequent drive for economy, no change was made in the earlier decision. Consequently not even a prototype of an operational swept-wing fighter flew before 1951, and no prototype fully representative of the production aircraft before late 1952."

Korea Sounds a Warning

In 1950, when war broke out in Korea, the decision to re-equip in 1957 had to be revised. The steps taken were as follows:—

"In the fighter field a substantial production order for the swept-wing day-fighter was placed off the drawing board in October 1950, although its first prototype did not fly until nine months later. Several hundred more were ordered in the early months of 1951. This was later named the Hunter. It was also decided as an insurance to order off the drawing board an operational version, proposed by the makers, of a research aircraft, the S.535, which it was hoped could get into production before the Hunter; prototypes and 100 production aircraft were ordered in November 1950 and the production order was increased by 50 early in 1951. This was later named the Swift. Owing to the emergency, production orders for the Hunter and the Swift were placed much earlier in the development phase than would normally be the case.

"In the same way a production order for the Valiant bomber was placed early in 1951, before the first prototype had flown. At the same time it was decided to order the Sea Venom as an all-weather fighter for the Fleet Air Arm, and again a production order was placed before the first prototype had flown.

"Clearly the decision to place these orders at this stage meant taking exceptional risks . . . on the other hand, it offered a hope that some of the latest aircraft would be available earlier. . . ."

In the section headed "Progress 1951-1955" it is remarked that Valiant deliveries have started and will continue during the coming year—"development troubles have been remarkably few for an aircraft of its size and performance." Of the Vulcan and Victor it is stated that good progress has been made despite setbacks through accidents to prototypes. The Canberra is described as "having proved a successful and versatile aircraft." Among the fighters the Venom fighter bombers and Venom and Meteor night fighters are stated to be "usefully filling the gap until the latest swept-wing aircraft are introduced." The White Paper goes on:

"In particular, the two-seater night-fighters with their airborne and ground equipment afford a defence against night attack which we believe is superior to that of any other country."

The statement next turns to the Hunter and Swift, in which "serious development troubles" were encountered. It says:—

"The decisions of 1950-51 to order many hundreds of these aircraft meant that while development was still in a very early stage, tooling up and other preparations were rapidly pushed ahead for production of swept-wing aircraft with a large number of new features, such as axial-flow engines, power controls, heavier armament, and other more complicated equipment. All these had to be introduced and developed together. They had to be tested concurrently. Modification to one feature often meant modification to many others. This had to be done under the handicap that only a few prototypes had been ordered. A single intractable aerodynamic problem from time to time monopolized the flying time of all the available aircraft or grounded them so that all other development flying, including the flight testing of guns, radar and other equipment, had to be put back. For instance for a long time difficulty was experienced in making the Hunter air-brake slow the aircraft effectively without upsetting the pilot's aim. Meanwhile production built up rapidly, and although this enabled early production aircraft to be diverted to assist in development flying, it also meant that increasing numbers of aircraft were coming off the production line while some major features of the design were still unsatisfactory.

"The first prototype of any mark of Hunter flew in July 1951, the first representative prototype in November 1952. The main troubles have been largely overcome, and substantial numbers of Hunters have already been delivered to the Royal Air Force. There are still certain directions in which the Hunter's performance could be improved; on these development is proceeding. Apart from these there is a problem with the guns: the firing of the guns causes interference with the flow of air into the engine, and when this happens in the rarefied atmosphere encountered at extreme altitude, it may lead to the engine stalling; this trouble, which has been experienced in other countries even with more lightly armed aircraft, affects significantly only certain marks of Hunters. Measures already taken have effected a substantial improvement and further measures are in hand. . . ."

Future of the Swift

The Swift, says the report, was based on a research aircraft intended primarily to explore aerodynamic problems:—

"Subsequently, in the emergency of 1950, it was decided to turn it into an operational aircraft; in addition to introducing armament and all the rest of the operational equipment required for Service use, it was decided to replace the Nene engine by the larger and more powerful Avon. The resulting changes from the original design so complicated the process of development as to become the basic cause of many of the difficulties which have been encountered.

"Production of the first mark with two Aden guns was ordered, as has been stated in November 1950; the first prototype did not fly until July 1952. The second mark, with four Aden guns, involving important changes to the wing, was ordered in April 1951 but a four-gun aircraft did not fly until May 1953; this was also the first aircraft representative of the Mark 4 which was the mark for which the largest orders were placed for the R.A.F. The aerodynamic performance of all marks proved disappointing and great efforts have been made by all concerned to get the aircraft right. Meanwhile, as in the case of the Hunter, production has been rapidly building up.

"After a series of exhaustive tests, it has been decided that the Swift Marks 1 to 3 cannot be brought to an acceptable operational standard. Within the past few days, certain modifications have been introduced into the Mark 4. Further tests are taking place to see whether these have produced a sufficient improvement to warrant putting this mark into service with the R.A.F. It will be possible to replace the Mark 4 Swifts by Hunters if necessary. Development is continuing for the time being of other marks designed for certain specialized functions."

The White Paper then goes on to review future R.A.F. and current Naval machines, remarking that the Sea Hawk and Sea Venom are of less advanced design than the R.A.F. swept-wing fighters and their development troubles have therefore been less serious. Being the first military aircraft in the world with a turboprop engine, the Wyvern has encountered more than its fair share of development troubles, particularly in regard to the engine and airscrew control system: "Up to date it has not proved successful for its designed purpose as a carrier-borne aircraft, but work is still proceeding with a view to remedying its defects." Gannet development and production have proceeded smoothly "apart from some difficulty with the engine . . . which has been overcome."

The publication concludes with an appendix in which various aspects of research and development are discussed. Explaining the modern conception of an aeroplane as a "weapons system," it says that since the failure of any one link in the combination could make the weapons system ineffective, the ideal arrangement would be for co-ordination of the various components to rest on one individual, the aircraft designer; experience has shown that this is not completely attainable, but it is the intention to move in this direction as far as practical considerations allow.

Discussing the subject of modifications in relation to production delays, the report cites two classes of modification, (a) those essential for safety and to bring an aircraft to an exceptional operational standard and (b) those intended to extend performance. These present a constant dilemma, for while they can prolong the useful life of a type, too many may cause major changes in design: "This second class of modification should therefore be introduced at some convenient point in the production process in order not to delay delivery of earlier versions."

The effects of the new policy of ordering prototypes in larger numbers are also explained.

*Cmd. 9388, *Her Majesty's Stationery Office; price 6d.*

On this and the opposite page are the first pictures of the Bristol Type 173 Mk 3 with its newly installed four-bladed rotors, to which Mr. Hafner referred in his lecture. It will be seen to differ from the design previously publicized under this designation.

Bristol Type 173 Helicopter Developments

First Flights of Mk 3 Described by Mr. Hafner in Lecture

AT the sixth meeting of the Helicopter Association's 1954-55 lecture programme, held in the library of the Royal Aeronautical Society on February 11th, a paper entitled *Development Experiences with the Bristol Type 173* was presented by Mr. Raoul Hafner, chief helicopter designer to the Bristol Aeroplane Co., Ltd. Dr. G. S. Hislop was in the chair.

Mr. Hafner began with a brief description of the Types 171 and 173 helicopters. The latest development was the 173 Mk 3, which was fitted with four-bladed rotors and would eventually have Leonides Major engines. Although many components in the control systems of the two types were identical, the control problems of the 173 helicopter differed materially from those of the type 171.

On the 171 helicopter, control was achieved by direct tilting of the cyclic-pitch spider on the rotor head. In the type 173, fore-and-aft cyclic-pitch control was obtained through movement of two T-shaped levers located below and forward of the rotor heads. Fore-and-aft movement of the control column caused a rotation of these two levers and resulted in a simultaneous fore-and-aft tilting of the planes of the two rotors.

The control movement also affected the collective-pitch mechanism through a "mixing" control and introduced a differential collective-pitch change into the system. Thus, a powerful pitching moment was provided in addition to the fore-and-aft tilting. For trimming purposes, an independent collective-pitch adjustment was incorporated in the system which was actuated by a trimming wheel in the pilot's cockpit. Movement of the collective-pitch lever increased or decreased the pitch of the two rotors simultaneously, irrespective of any collective-pitch change introduced by the fore-and-aft control through the "mixing" box or by the trimming mechanism.

Lateral cyclic-pitch control was achieved by a rotation of the two T-levers in opposite senses, causing a lateral tilt of the two rotors in the same sense. The levers also provided control in yaw. In this case they were moved fore and aft in opposite senses, through movement of the rudder pedals, to produce a lateral tilt of the two rotors in opposite senses and a resulting yawing couple in the machine.

The twist-grip throttle on the collective-pitch lever controlled both engines but, to cater for the engine-failure condition, a special mechanism had been incorporated in the collective-pitch/throttle linkage to allow full throttle to be obtained from one engine with only moderate pitch on the two rotors. A pair of independent throttle levers, connected in series with the twist-grip, were provided in the pilot's cockpit for ground handling and emergency simulation purposes.

Early flight trials had brought to light the fact that the induced velocity at forward speed in the rear rotor was greater than had been anticipated, and this necessitated increasing the range of the "mixing" control. The latest modification to this mechanism allowed for a differential collective-pitch change of 3 deg between the two rotors with the full fore-and-aft movement of the cyclic-pitch control.

Control in yaw was also found to be insufficient at first. The combined effects of differential rotor torque and the lateral tilt of the rotors (due to blade flapping) at forward speed caused a strong yawing moment to port in cruising flight. In the hovering condition, the moment was to starboard. This was compensated by fitting tabs to the fins and by increasing the range of the rudder control.

The lecturer went on to describe some of the experiments carried out at Filton in connection with the backward take-off technique for an emergency condition at a city-centre terminal. At the outset, a device had been fitted to a 171 helicopter by means of which the engine power could be reduced suddenly to a value equivalent to the power loading of a type 173 helicopter on one engine. The trials were continued with the 173 Mk 1 and it had been established that the safety height for this machine was 200ft. Below this height, the pilot would land back at the take-off point in the event of one-engine failure; above it, he could continue his flight on the remaining engine and gain forward speed.

Another series of experiments described by the lecturer were the impedance tests carried out to determine the source and cure of any ground-resonance tendencies. The ideal form of undercarriage to obviate any susceptibility to ground resonance was one which, though having a high degree of stiffness in the vertical sense, would yet allow a "soggy" lateral movement of the rotor hubs. A new undercarriage possessing these characteristics had been fitted to the type 173; and another interesting feature was the new design of drag-link friction dampers which also had a bearing on the problem of resonance. The new dampers were similar in operation to a spring-loaded multiple-plate clutch and they provided a graded increase of damping with amplitude of blade movement. They also served as a torque-limiting device for the synchronizing shaft between the two rotor hubs. Torque in the shaft was limited by the dissipation of energy in the dampers.

Mr. Hafner dealt at some length with the questions of stability and vibration. After an examination of the stick forces in various conditions of flight, he said that the addition of stub wings on the 173 Mk 2 had made a noticeable improvement in the machine's stability characteristics. With the stub wings fitted there were no sudden changes in trim due to stalling and "unstalling" but, on the other hand, there had been no appreciable reduction in vibration. He felt that stub wings would be of value to the large transport helicopter, but not for a small machine or one which was to be used, to a large extent, in slow and hovering flight.

On the question of vibration, he said that, by careful balancing and tabbing of blades, vibration could be reduced to acceptable levels. In this connection he was very pleased to be able to announce to the meeting that the Bristol 173 Mk 3, with the new four-bladed rotors, had made its first three flights that morning; the results had been most encouraging. The amplitude of vibrations had been reduced by no less than 70 per cent in comparison with the Mk 1 and Mk 2 versions with three-bladed rotors. He had been a passenger on one of the flights and considered it was the smoothest helicopter in which he had ever flown.

The lecturer concluded by drawing a comparison between the twin tandem helicopter configuration and the single-main-rotor/tail-rotor type. They were both twin-rotor machines and the difference was not in the number of engineering elements which they incorporated, but in the size of those elements. Scale effect was against the construction of large rotors because, to keep the same coning angle for low vibration-characteristics, an increase in blade weight was unavoidable.

A similar argument applied in the case of gear boxes and transmission shafts. To keep the same tip speed, a large single main rotor had a slower speed of rotation and the weight of gears increased with the greater speed reduction ratio. Taking the case of a hypothetical single main rotor type equivalent in size to the 173 helicopter, a design study showed that the difference in the all up weight of the two configurations was 1,200 lb, in favour of the tandem-rotor machine. It was admitted that the twin

tandem helicopter required slightly more power at approximately 50-60 kt airspeed, but the configuration showed up to better advantage at the high end of the speed range and in hovering flight.

THE DISCUSSION

PROF. H. B. SQUIRE (Imperial College) asked whether, in the fore-and-aft-control, the differential change in collective-pitch, through the "mixing" box, was more important than the change in cyclic-pitch which caused the rotors to tilt.

MR. J. WOOTON (Hunting-Percival) thought that a reduction in vibration might have been expected with the addition of stub wings and asked why this was absent in the 173 helicopter.

MR. R. L. LICKLEY (Fairey) inquired whether the lecturer considered that impedance testing was a sufficient guarantee that ground resonance trouble would not occur. He also asked what was the weight penalty with the two four-bladed rotors.

W/C. R. A. C. BRIE (B.E.A.) said that he had noticed from one of the graphs shown that there was an undesirable divergence of the fore-and-aft control at an airspeed of 35-40 kt. Since this was the critical approach speed under instrument flight conditions, would an automatic pilot be necessary? He also asked at what particular size of helicopter the tandem rotor configuration began to have advantages over the orthodox single-main-rotor type.

MR. T. L. CIASTULA (Saunders-Roe) expressed doubt as to whether the impedance tests would give the full answer to ground resonance problems and he questioned the lecturer as to what control forces were experienced in the 173 helicopter.

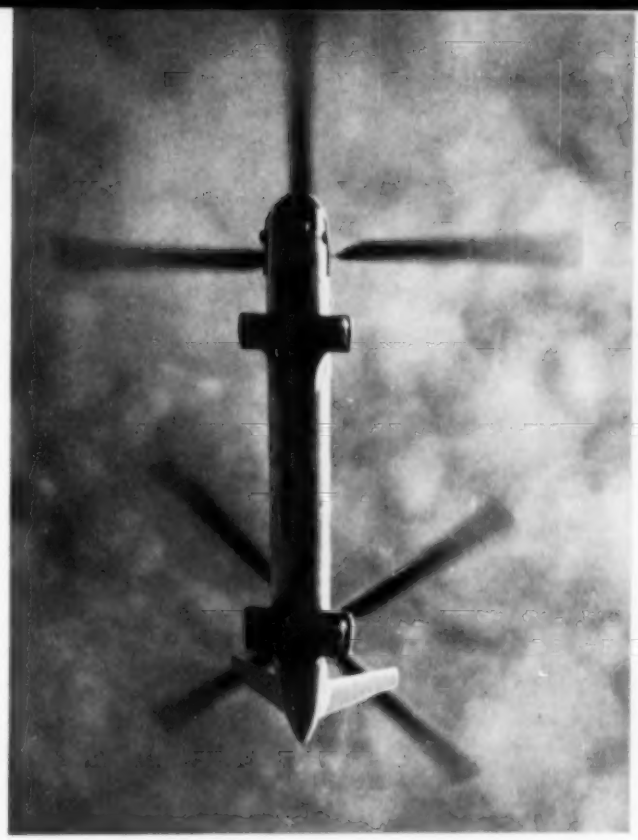
MR. F. H. POLLICUTT (Hunting-Percival) said he was interested in the comparison between the tandem rotor and single rotor machines, but he thought the lecturer had omitted two important factors, vibration and cost. He believed that both these factors favoured the single rotor machine.

MR. G. H. TIDBURY (Saunders-Roe) recalled some experiences in the development of the Air Horse helicopter and said that with the three-rotor configuration there had been no control instability.

MR. HAFNER, replying to the discussion, said that the differential collective-pitch change was the most important element in the fore-and-aft control. It was possible to do without the cyclic tilt, but not the collective-pitch element. Whether or not the addition of stub wings reduced the vibration level of a helicopter depended on the individual design. It was a complex problem and the increase of surface area in the downwash of the rotors sometimes tended to nullify the reduced vibration from the rotors themselves. He said that although no positive guarantee could be given that freedom from ground resonance would be obtained by impedance testing, at least it was a scientific and rational approach to the problem and was better than the method which involved tying the helicopter rigidly to the ground. The direct increase in weight with the four-bladed rotors was in the region of 200 lb, but the permissible all-up weight would be increased also. The tandem rotor configuration was more favourable for helicopters of the size of the Bristol 173 and above.

The controls on the type 173 were not power-operated and the only irreversibility in the system was in the collective-pitch mechanism and the trimming device. For helicopters of greater all-up weight, power assistance might be necessary, but it should be possible to revert to direct control for emergency conditions and not duplicate the power operation. An automatic pilot would certainly be an advantage and he asked Mr. Hosegood, Bristol chief helicopter test pilot, to answer the questions regarding control in flight.

MR. C. T. D. HOSEGOOD (Bristol) said that it would be better for the pilot to hold a constant airspeed in the slow-approach condition. There was no problem involved in this, but, if changes in airspeed were required, larger stick-movements would be necessary. He thought it would be better to keep the airspeed lower on the approach, below 30 kt, where the reversal of fore-and-aft stick movement did not apply.



MORE B-66 DETAILS

ON pages 205-208 last week was presented an analysis of the design of the Douglas A3D Skywarrior, which concluded with a note upon the U.S.A.F. machine derived from it, the B-66. Douglas have now issued the first quantitative data upon the latter.

Powered by two Allison J71-A-9 turbojets of 10,000 lb thrust each, the B-66 is being built at Long Beach in two forms: the B-66B bomber and the RB-66B reconnaissance machine. The former is heavier but has shorter range; nevertheless it "meets tactical requirements for delivering the most potent weapons." The RB-66B "is designed to fly at all altitudes up to 45,000ft and its range will permit penetration into enemy territory for all-weather round-the-clock photographic and mapping missions by the most modern equipment yet devised . . ."

Both types measure 72ft 6in in span, 75ft 2in in length and 23ft 7in in height. Empty weights are 39,686 lb (RB) and 40,330 lb (B); gross weights are given as 70,000 lb (RB) and 78,000 lb (B) and overload weights as 79,000 lb (RB) and 83,000 lb (B). Even on the gross wing area of 780sq ft, the last figure results in a wing loading of 106.5 lb/sq ft. Other data are: total aileron area, 32.6sq ft; total flap area, 108.8sq ft; total tailplane area, 114.8sq ft; total elevator area, 52.2sq ft; fin area, 129.9sq ft; rudder area, 32.5sq ft; main tyre size, 49 × 17; nose tyre (one), 36 × 11.

SILENCE IN FRANCE

RECENT British experiments with a Vokes silencer on a Westland-Sikorsky S-55 helicopter heighten interest in the news that the Société des Avions Paul Aubert have developed a silencer for use on light aircraft, and that it has been experimentally installed in the Aubert 204 four-seater and a number of Norécrins. At the request of the Technical Services it has also been applied to an N.C.856 A.O.P. aircraft, and as a result of tests is likely to be quantity-produced for all machines of the type. The reduction of noise level is reported to be of the order of 60 per cent, while the loss of power does not exceed one per cent, representing a decrease in speed of only 1.2 m.p.h. Offsetting this small penalty is the possibility of easily installing a cabin-heating system.

CANCELLED CONTRACTS

THAT the United States Navy has cancelled contracts for about 1,000 aircraft at a cost of more than $1,000 million (£357 million) because they "could not perform to specification," was officially disclosed in Washington recently by Mr. Charles Thomas, Secretary of the Navy, at a hearing of the House of Representatives Armed Services Investigating Sub-Committee. This fact, he said, was the major reason why the Navy had reduced requests for new air funds next year from $1,900 million to $750 million.

In closed testimony (a censored version of which was later released) Mr. Thomas said that increased production for the Navy, prompted by the Korean war, had produced some unforeseen production difficulties, delivery delays, and aircraft with "unsatisfactory performance." He revealed also that at one time the Navy units in Korea were so seriously short of "attack-type aircraft" that "losses of this type in some months of 1952 were greater than new deliveries from the factories." The Navy was now operating under a new system of putting into production only "fully tested aircraft." Mr. Thomas said that he was describing difficulties under the previous administration.

ADASTRAL REBECCA

THE Adastral Players recently presented Daphne du Maurier's *Rebecca* at the Fortune Theatre, London. Amongst those attending this workmanlike production were the Chief of the Air Staff, Marshal of the Royal Air Force Sir William F. Dickson, and the Under-Secretary of State for Air, the Hon. George Ward. The cast had to fight the fact that this play is extremely well known, and that many of the audience might be making comparisons with the film directed by Alfred Hitchcock. One in particular who triumphed over this disadvantage was Pamela Bickell who, as Mrs. de Winter, seemed to have exactly the right qualities for the part. The prompter was excessively prompt, which might well have unsettled the players, but Ivor Cadwallader, Christine Smith and Patricia Busby were undismayed, whilst Frank Barnard made a most convincing boatbuilder. The producer was Arthur Beckess, and incidental music was played by a section of the Ariel Orchestra.

As a private venture, the Fairchild Engine and Airplane Corporation have installed two of their J44 turbojets on the wing-tips of a production C-123B assault transport (also built by Fairchild, although the basic design was by Chase). With one engine out, as shown here, the rate of climb is increased from 150 to 500 ft/min. The 1,000-lb-thrust turbojets draw fuel from the main tanks and can be sealed by intake doors when not in use.

AIRCRAFT INTELLIGENCE

U.S.A.

Bell VTO. The interesting point is raised by *Aviation Week* that, owing to the loss of thrust resulting from a rise in ambient air temperature, the Bell vertical-jet prototype (see *Flight*, February 11th) is restricted to cold-weather flying.

Boeing bomber electronics. Illustrative of the growth of what the Americans term "avionics" are the following figures of the weights of such equipment carried by four famous Boeing aircraft: B-17, 1,600 lb; B-29, 2,100 lb; B-47, 5,400 lb; and B-52, 6,000 lb. The latter figure is surprisingly light, bearing in mind the size of the aircraft and the bulk of its bombing system. (For comparison, it has been stated that a modern British medium bomber carries some 9,000 lb of electronic gear, and that this consumes 100 kW of electrical power —a figure which, according to the Parliamentary Secretary to the Ministry of Supply, may well be doubled in future types.)

Convair XB-58 Hustler. Construction of this supersonic bomber is going ahead rapidly at Fort Worth, and the prototype is to fly this year. (As previously reported, it has a five-per-cent delta wing carrying four podded General Electric J79 turbojets.) It is now learned that this wing, and the rear fuselage, incorporate 1,000 to 1,200 sq ft of stainless-steel honeycomb-sandwich skinning in the regions close to the "hot zone" of the J79s.

Ryan VTO. It is learned that this experimental prototype will be powered by a single Rolls-Royce Avon turbojet of an advanced mark. This engine is now being inspected at the company's San Diego factory preparatory to installation in the almost-complete airframe. Flight trials are scheduled to start early in the spring.

New missile designations. The U.S. Air Force has abandoned the designation "pilotless aircraft" and has re-classified its unmanned bombers and intercepters accordingly. At the same time, the organization of operating units has been revised, the terminology now being "tactical, strategic or air-defense" missile squadrons or wings. Examples of the new designations are: tactical missile TM-61 (formerly Martin B-61), Matador; strategic missile SM-62 (formerly Northrop B-62), Snark; intercepter missile IM-99 (formerly Boeing F-99), Bomarc; guided aircraft rocket GAR-98 (formerly Hughes F-98), Falcon; and guided aircraft missile GAM-63 (formerly Bell XB-63), Rascal.

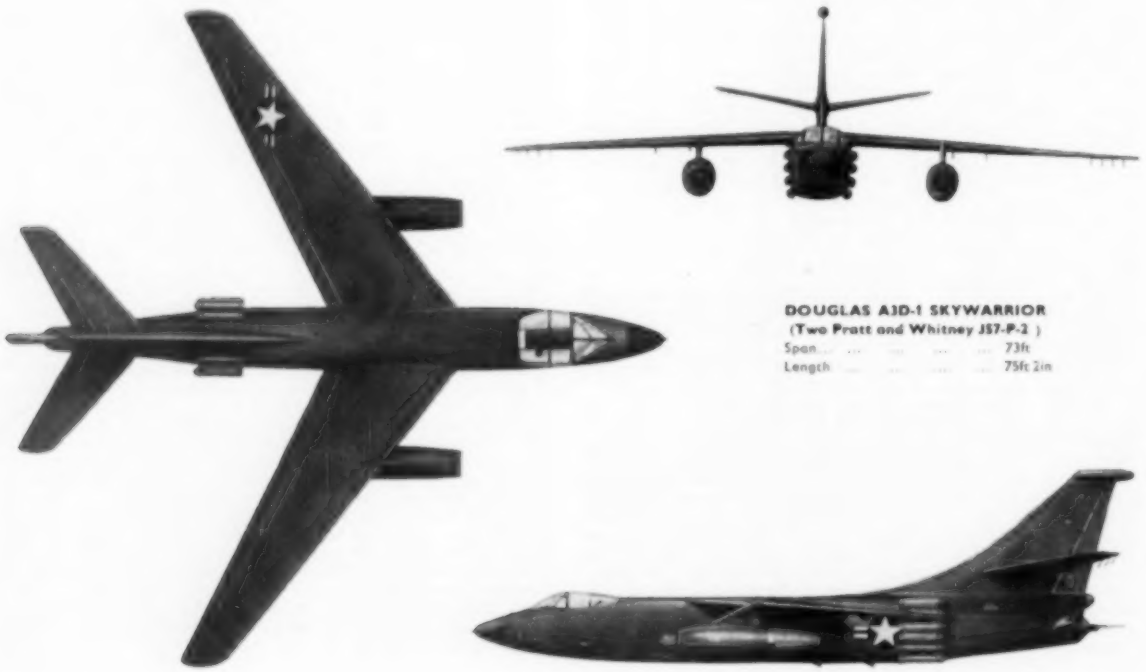
France

Dassault Mystère IV-B. According to an Italian journal, the prototype Mystère IV-B is back in the shops being fitted with a single-piece "slab" tailplane. Production IV-Bs are expected to be powered by an afterburning Atar 101-G21 of 8,800 lb thrust.

Fouga C.M. 170M. With this designation, a fully "navalized" version of the twin-jet Magister light trainer has been developed. We learn that two prototypes have been ordered, and that construction of both is already well advanced. They incorporate various modifications, including catapult and arrester gear, a long-stroke Messier undercarriage and a sliding cockpit canopy to *Aeronavale* requirements.

Hurel Dubois HD-321. The second prototype HD-32 is being re-engined with single-row Wright Cyclone 9H units of 1,475 h.p. each. With these installed it becomes the HD-321, and is expected to offer marked advantages over the Twin-Wasp version. Over a 310-mile stage, for example, the 321 should carry a payload of 16,300 lb (instead of 12,750 lb), cruising at 179 m.p.h. (HD-32 figure, 165 m.p.h.).

S.F.E.C.M.A.S. Gerfaut. Last Friday the Gerfaut 1B, described as a "pre-operational prototype," flew faster than sound in level flight solely on the power of an Atar 101-C. This modified machine has a wing of greater area than that originally fitted, and M. Brucat, the test pilot, reported an improvement in take-off and landing characteristics. A braking parachute was used for landing. The Gerfaut 2 is nearly ready, and this later aircraft is expected to have a "canard" delta tailplane at the forward end of the fuselage.



DOUGLAS A3D-1 SKYWARRIOR
(Two Pratt and Whitney J57-P-2)

Span	73ft
Length	75ft 2in

Guided weapons for defence by FAIREY
THE FAIREY AVIATION COMPANY LIMITED · HAYES · MIDDLESEX

de Havilland Propellers for the *Viscount*

Central African Airways

have chosen de Havilland hydromatic, constant-speed and feathering propellers for their fleet of Vickers Viscount airliners (Four Rolls-Royce Dart engines)

DE HAVILLAND PROPELLERS

Above a downy bed of stratus, Hunter F.2s of No. 257 Squadron array themselves in echelon starboard. They are descended from illustrious forebears, among which was the Fury biplane (below)—the R.A.F.'s first intercepter.

THE HUNTERS ARE HERE

Their Ancestry: and a Day with the Squadrons at Wattisham

PALADIN among military aircraft is the intercepter—a fighter designed to take off at the shortest notice, ascend to the designated level in the briefest time possible, engage its quarry forthwith and destroy it with certainty. It has a British ancestry, stemming from Air Ministry Specification F.20/27, to the requirements of which biplanes by Hawker, Bristol and Gloster and monoplanes by Westland and Vickers were submitted for tests during 1929. The prescribed engine having proved capricious, Hawker and Fairey put forward private-venture biplanes, using the brilliant new Rolls-Royce "F," or Kestrel, and there ensued the famous tussle Hawker Hornet *versus* Fairey Firefly, from which the Hornet—later renamed the Fury—emerged victorious in 1930. The prize was a production order for sufficient aircraft to equip

Two great fighters in the Hawker tradition: the Hurricane and the Hunter.

The large picture above is one of the most gratifying and, we think, impressive published in this journal for some years, showing, as it does, 24 Hunters in squadron service with the R.A.F. On the immediate right are six Hunter F.2s of No. 257 Squadron, and, far right, seen at Wattisham, 30 Hunter F.1s and F.2s, respectively of Nos. 43 and 257 Squadrons.

and are brought to bear by means of a radar-ranging sight.

The Hunter is the first Hawker jet fighter to serve with the R.A.F. and its particular history may be considered to date from September 2nd, 1947, when, at Boscombe Down, Hawker's W. ("Bill") Humble made the initial flight in his company's first jet fighter prototype, the P.1040. The seven years between this event and the issue of Hunters to the squadrons had seen the phased development of partially swept and fully swept prototypes, and then the arduous process of adaptation and development to meet a particularly stringent operational requirement.

The P.1040 had straight wings and straight tail surfaces, and was powered by a Rolls-Royce Nene, breathing through wing-root intakes and having a Hawker-patented bifurcated tailpipe. Although it had not been adopted by the R.A.F. (which Service was fully committed to the Meteor and Vampire), the new machine was developed, to Specification N.7/46, as a carrier-borne fighter for the Royal Navy, and this variant made its first public appearance at the S.B.A.C. Display of 1948. Thence-forth the Sea Hawk project went its own way as work on more advanced swept-wing, land-based fighters was put in hand. It is fitting to mention here, however, that the P.1040 (serial number VP401) was later adapted for flight-testing the Armstrong Siddeley Snarler rocket motor, and with its mixed powerplant was redesignated P.1072. This pioneer British aircraft appeared in the S.B.A.C. static display of 1951.

Hawker's first venture in sweepback was the building of the P.1052, which resembled the P.1040 in all essentials except that the wings were swept at 35 deg. Two examples—serial-numbered VX272 and VX279—were built during 1949, and the former was subsequently "navalized" for carrier trials.

The next development phase entailed the conversion of VX279 to the "all-swept" configuration, under the designation P.1081—a conversion, be it said, which was effected in the remarkably short space of four weeks. While the wings, under-carriage and forward fuselage remained unaltered, a completely new tail, with swept-back surfaces, and a tail jet-pipe, with provision for reheat, were incorporated. Only three days after the first flight Trevor ("Wimpy") Wade gave a spectacular demonstration in Belgium.

Development flying continued for almost a year—until, on April 3rd, 1951, Wade lost his life when the P.1081 was destroyed.

The next design to materialize was far more ambitious in terms of performance and armament. Bearing the Hawker project number P.1067, it conformed to Specification F.3/48 and bore the Service number WB188. This fighter was the first true Hunter, though the name was not officially confirmed until many months after the first flight—by S/L. Neville Duke at Boscombe Down on July 20th, 1951. A few weeks later Duke presented it at Farnborough with shattering effect. This first prototype, like the second (WB195) which flew in May 1952, was powered with a Rolls-Royce Avon at 7,500 lb thrust, the fitting of the Avon engine being signified by the suffix F.1. The third prototype was the first F.2, powered by an Armstrong Siddeley Sapphire. Its serial number was WB202 and it was first flown on November 30th, 1952.

While development flying of these prototypes was going forward, plans for large production were being implemented; but, as Sir Sydney Camm, C.B.E., F.R.Ae.S., director and chief designer of Hawker Aircraft, Ltd., has himself remarked, this was a task which was beset with many difficulties, not the least being the lack, in the early stages, of technicians, skilled craftsmen, jigs,

(Continued on p. 242, after double page of Hawker jet-fighter development pictures)

THE HUNTERS ARE HERE . . .

three R.A.F. squadrons, of which No. 43, at Tangmere, was the first. Its Furies were delivered during the spring of 1931, and a flight performed aerobatics at the R.A.F. Display of that year. "They were certainly fast," *Flight* observed, "but it may, perhaps, be doubted that they attained the 250 m.p.h. in the dive which the loud-speakers announced."

Now, after a quarter of a century, during which period the names Hurricane, Typhoon, Tempest and Sea Fury have been writ large in the scrolls of military history, another Hawker intercepter—the graceful Hunter—is to be seen in R.A.F. service. By a happy turn of fate the first squadron to be equipped was again No. 43; and if, as we have said, an element of doubt was expressed in respect of that squadron's first demonstration at Hendon (in point of fact the Fury's terminal velocity was all of 350 m.p.h.), there is abundant aural proof that the Hunter is readily capable of exceeding the speed of sound in a shallow dive. As for armament, the Fury mounted two 0.303in Vickers guns, aimed by means of the Aldis and ring-and-bead sights of basic 1918 pattern, whereas the Hunter commands the devastating fire-power of four 30 mm Aden cannon, which are installed as a self-contained "pack"

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HAWKER JET-FIGHTER DEVELOPMENT

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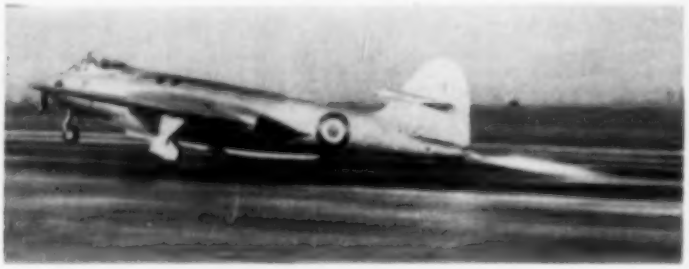

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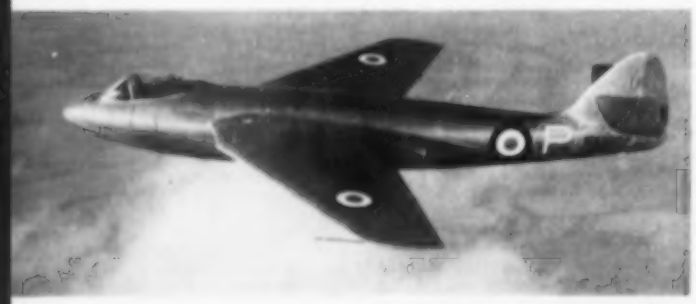
(1) P.1040. (2) Sea Hawk F.1 prototype. (3) Sea Hawk F.1 (production). (4) P.1072. (5) P.1052 (first prototype). (6) P.1052 ("navalized").

THE HUNTERS ARE HERE . . .



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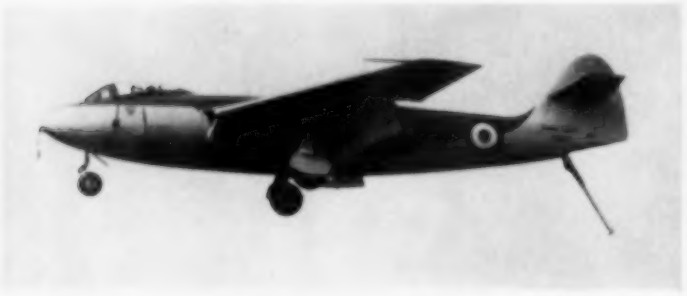

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(7) P.1052 (second prototype). (8) P.1081 (P.1052, second prototype, remodelled). (9) P.1067 (Hunter F.1), first prototype. (10) Hunter F.1 (first prototype) modified for speed record.

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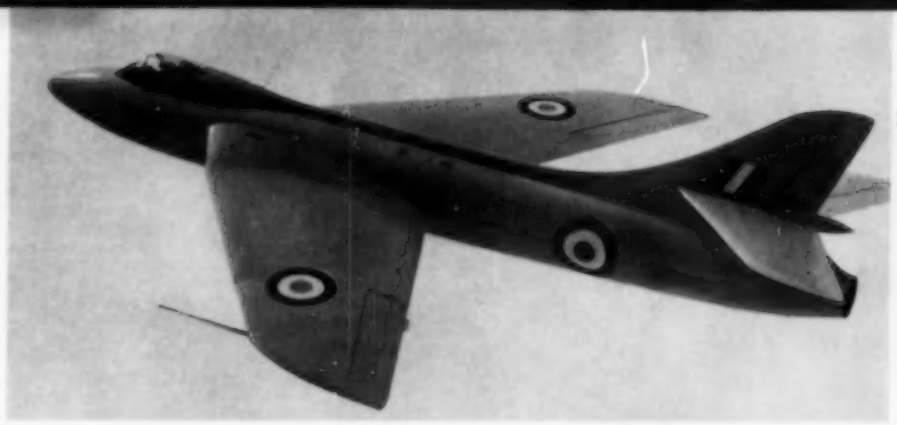

(11) Hunter F.1 (second prototype). (12) Hunter F.2 (first prototype). (13) Hunter F.1 (first production aircraft).

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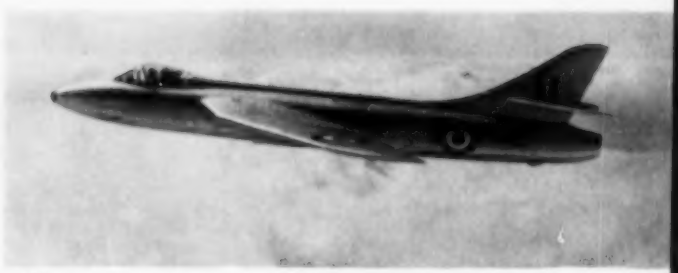

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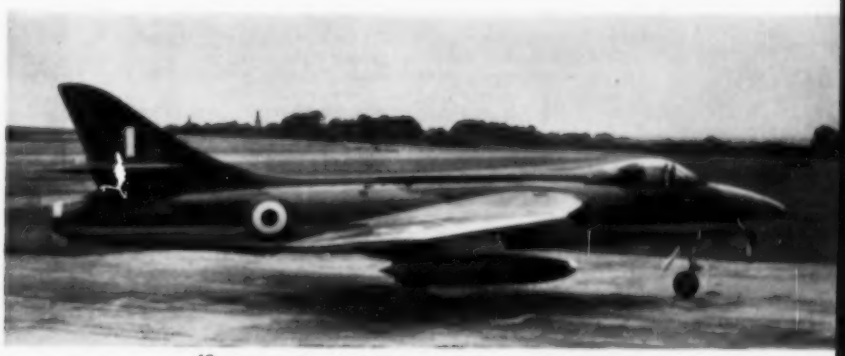

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(14) Hunter F.1 (later production, with under-fuselage air brake). (15) Hunter F.1, with under-wing tanks. (16) Hunter F.2 (early production). (17) Hunter F.2 (later production, with under-fuselage air brake).

16

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(18) The latest Hunter variant of which a close-up photograph is available —the Avon-powered F.4.

Hunter mainplanes in production at a British factory.

THE HUNTERS ARE HERE . . .

tools and materials. In many directions the outlook was bleak indeed.

The vicissitudes of Hunter production were admirably outlined last April by Mr. E. H. Jefferson, general manager of Hawker Aircraft (Blackpool), Ltd., and a director of the parent company, in a paper before the Society of Automotive Engineers in New York. Mr. Jefferson made the point that from the date that Hawkers first knew that they were going to receive an order to the time when the first production Hunter was flying only two years and seven months had elapsed. Furthermore, as the Hunter was a new aircraft the company had to start from zero and build a completely new production set-up at a time when production of other types of aircraft had been allowed to run down, with loss of much skilled labour which sometimes seemed almost impossible to replace. An even more serious aspect was the finding of firms to make large jigs and tools in the numbers required —3,250 tool designs and about 40,000 jigs, tools and fixtures. The Government's "super-priority" scheme only partially produced the required results, since priority had to be allocated to so many items that suppliers and sub-contractors were often unable to give any major preference. Additionally there was the continuing demand for exports.

Eventually, toolmaking difficulties were overcome by a combination of two methods. The first took care of initial detail and sub-assembly work and involved a compromise—the development and use of "rough tools," prepared not by the virtually unobtainable toolmakers but by skilled fitters. Although capable of manufacturing several hundred parts these tools were intended as a temporary measure. Such methods obviously could not be employed for major assembly jigs; here it was a matter of searching far and wide until someone with the capacity to accept orders could be found. Eventually a large number of jigs were procured from such Italian firms as Macchi, Breda and Fiat.

Conforming to World War II practice, Hawkers had decided that the Hunter should be divided into major units which could be completed individually and would be available as fully equipped spares. Their size depended partly upon structural design and partly upon Service requirements for transportation; but these units should not be confused with manufacturing sub-assemblies, into which the airframe was further sub-divided.

The Hunter airframe is broken down into six fully interchangeable major components: front fuselage, which carries the cockpit, armament pack, nosewheel and cowling for radar-ranging sight and camera gun; centre fuselage, with integral wing roots, engine supports and air intake ducts; detachable rear fuselage with integral fin base and removable jet pipe/tail cone unit; tail unit assembly; and mainplanes, complete with the main undercarriage legs. For final assembly it was necessary only to connect the structural members and to plug the pipes and leads together.

Mr. Jefferson has pointed out that one reason for this method was the difficulty inherent in building a complex aircraft in a number of factories some distance apart. During the early days the resources of the entire Hawker Siddeley Group were pooled for difficult items. Hawker Aircraft itself was far from being housed all under one roof. Production plans, therefore, called for the detail parts and main assemblies to be made in several places, with Kingston-upon-Thames as headquarters. There were two other factories in the south of England and assemblies were fed to the final-assembly plant and airfield about 30 miles from Kingston. Certain specialized components were sent 250 miles from Hawker Aircraft (Blackpool), Ltd.

When production for the R.A.F. was proceeding at a satisfactory rate a U.S.A. off-shore procurement order was placed for 450 Hunters, to be delivered by June 1956. It was not, however, necessary (and was, in fact, impossible) for new factories to be erected to build off-shore Hunters alone, and the order is being met from the existing organization by continuing production at the peak rate which had been planned to meet R.A.F. requirements. Thus, the off-shore order assured a longer run of peak production and promised a level of capacity not otherwise possible. As the aircraft are completed the M.o.S. and NATO representatives will decide between themselves which shall go to the R.A.F. and which to other NATO countries.

Over and above the off-shore orders placed with Hawker Siddeley further contracts were awarded to Dutch and Belgian firms, so that eventually Hunters will be built by three companies in Holland—Fokker (who are to undertake the majority of manufacture in that country), Aviolanda and de Schelde—and by two in Belgium—S.A.B.C.A. and Avions Fairey.

Many special machine tools for Hunter production, both on the Continent and in Great Britain, had to be obtained from the U.S.A., and Mr. Jefferson has mentioned the fact that in an emergency the production jigs in the Hawker factories could quickly be dispersed to safe areas, for all main jigs are erected on "rafts."

Present orders are a measure of the Hunter's quality, and can be summarized as follows: for R.A.F. Fighter Command, an undisclosed but "substantial," number; for NATO, 958, made up as follows—468 for the R.A.F. under off-shore contracts, 112 to be built under licence by Fokker in Holland and by S.A.B.C.A. and Avions Fairey in Belgium (also under off-shore contracts), 156 to be built in Holland by Fokker for the Dutch Government, 192 to be built by S.A.B.C.A. and Avions Fairey for the Belgian Government, and 30 for Denmark, to be built by Hawkers in Great Britain. Sweden, a non-NATO nation, has ordered 120 Hunters at a price of £12 million, so that, quite apart from the Ministry of Supply contracts on behalf of the R.A.F., nearly 1,100 Hunters are on order from the various factories. These orders were followed last September by an M.D.A.P. contract delivered by U.S.A.F.E. for £367 million worth of Sapphire-Hunters and Javelins for the R.A.F., though the numbers of each type were not stated.

During 1954 photographs of large-scale Hunter production were approved for publication, and on June 24th of that year the Ministry of Supply granted clearance for the Hunter to enter service. The first squadron to be equipped (with F.1s) was, as we have said, No. 43—the "Fighting Cocks"—based at Leuchars and commanded by S/L. R. E. Lelong, D.F.C., a New Zealander and a Sabre veteran of Korea.

Throughout 1954 there were rumours and reports (many of them half-truths, or completely unfounded) that the Hunter was beset by various troubles. Certain it was that application of the air brakes caused an unacceptable change in aircraft attitude, and during January the F.1 prototype WB188 was to be seen with experimental braking surfaces on each side of the tailpipe, whereas in the original scheme the brakes had been located on the wings. After a lengthy period of experiment the now-familiar, externally applied "barn door" beneath the rear fuselage was standardized.

An armament demonstration at Boscombe Down during August 1954 bore witness to the staggering punch of the Hunter's four Aden guns, and it was then observed that a large streamlined collector-box for links and shell cases was carried beneath the gun pack. In recent weeks it has been officially intimated that this fitment is being standardized. Engine-surging troubles, admitted to have been experienced under certain conditions at extreme altitudes when the guns are fired, are more pronounced on the F.1 than on the F.2.

Early this year a Hunter F.1 appeared with pylon-mounted, finless, plastic under-wing fuel tanks of Bristol manufacture, and mention was authorized of the marks F.3, F.4 and F.5—the F.3 a reheat version now abandoned, the F.4 with an Avon and considerably increased tankage, and the F.5 a Sapphire-powered equivalent of the F.4. Although the modified Hunter XF833 demonstrated at 1954 S.B.A.C. Display had then been called the F.6, the airframe was, in fact, that of an F.1, adapted to take a more powerful Avon. The foreign Press reports that the engine of the F.6 will be the Avon RA.23.

A full description of the Hunter has not yet been authorized, but it can be said that the span, length, height and undercarriage track are, respectively, 33ft 8in, 45ft 3in, 10ft and 14ft 9in. The gross wing area is 340 sq ft, sweepback at quarter chord 40 deg, thickness/chord ratio (constant) 8.5 per cent, aspect ratio 3.3 : 1, and tyre pressure 190 lb/sq in. The hydraulic system incorporates separate accumulators for the power-boost units and is fed by a Dowty constant-volume two-stage pump. The system supplies power for undercarriage and flap operation, and for the flying control boosters. There is an emergency pneumatic system for lowering the undercarriage and flaps.

It has been officially announced that consideration is being given to the adoption of an all-moving tail, as it is considered that this might be an advantage "in later development."

As for performance, the Hunter gave its first public demonstration of supersonic diving at the NATO display at Brussels in July 1952. On the evening of the first day of the 1953 S.B.A.C. Display, over the historic course between Rustington and Kingston Gorse, a Hunter F.1 flown by Neville Duke broke the world's absolute speed record with an average speed for four runs of 727.62 m.p.h. His aircraft—the famous WB188—had been given a "needle" nose and a streamlined windscreen, and the Avon RA.7R turbojet made use of an afterburner. On September 19th, again in WB188, Duke raised the 100-km closed-circuit record to 709.2 m.p.h.—in distinctly unfavourable weather.

Hunters in Service.—To see the Hunters in R.A.F. service we made our way, on the icy morning of February 16th, to the stark Fighter Command base at Wattisham, in Suffolk. Hot coffee in the crew-room, and the warmth of an 11 Group welcome—accorded us by the A.O.C., A.V-M. H. L. Patch, C.B., C.B.E.—restored our circulation, and from the Station Commander (G/C. H. I. Edwards, V.C., D.S.O., O.B.E., D.F.C.), the Wing Commander Flying (W/C. C. S. Vos, D.F.C.), and squadron pilots we heard the Hunter's virtues extolled with unfeigned enthusiasm.

With a stiff cross-wind over the runway, and flurries of snow and sleet for good measure, we scaled the heights of flying control to witness a display. The squadrons engaged were No. 43, which had flown down from Leuchars, Fife, and Wattisham-based No. 257—commanded, we were agreeably surprised to find, by Maj. Howard Nelson Tanner, United States Air Force. Meteor N.F.14s of No. 152 Squadron and Meteor F8s of No. 263 took the air to afford some comparison in performance.

After a mass cartridge-start (a most engaging performance) the Hunters drew out of line one by one, to go squealing, squalling, booming and roaring out to the operational readiness platform and depart in pairs at five-second intervals into the snow-clouded air.

The tower seemed to shudder as a single machine hurtled by at (the Wingco. Flying assured us) a shade above 600 knots, which is some 720 m.p.h.; then, at a mere 450 knots, the formations appeared, precisely aligned as in L. W. McLaren's air-to-air photographs in these pages. At points on their route the pilots had contended with a cloud-base of 300ft.

The cold was such as to chill anything short of the very warmest enthusiasm; and that we certainly experienced. For too long we had waited for just this occasion, and now we found ourselves greatly heartened and profoundly impressed.

The merits of the Hunter, of course, are not confined to its flying qualities. Especially is it notable for its short "turn-round" time after an operational sortie, and, as we ourselves watched, ground crews had removed the gun panels from one machine; detached the barrels of the four Adens; lowered the massive gun-pack on to a special trolley; replaced the barrels; winched-up a new, re-armed, pack, weighing some 1,900 lb; recharged the oxygen bottles; changed the cine film; and completely refuelled the aircraft by means of the high-pressure valve in the port main wheel bay—all this in 5 min 42 sec.

As we had hoped, our visit was productive of information additional to that already given. On official authority, for instance, it can now be stated that the automatic gun-ranging radar is contained in the front fuselage, with the scanner in the extreme nose, enclosed by a laminated plastic radome. The radar works in conjunction with the gyro gun-sight, provides automatic ranging, and can be controlled by a twist-grip on the power lever. The rate of fire of the Aden gun was given as 1,200 rounds a minute, and one gathered that the entry of gases into the engine-air intakes may be minimized or prohibited by modifications to the gun ports and to the intakes themselves. Some danger remains, however, from the collection of explosive gases in the gun bay.

Discussion of operational techniques is precluded, but it can be said that at stand-by the Hunter pilots sit in their aircraft at the end of the runway and are in direct telephone contact with the sector controller. Thus, as a raid develops they are completely in the picture up to the moment of take-off.

Handling.—One of the most impressive aspects of the Hunter—and there are many—is the way in which it has been accepted by the squadron pilots. It is remarkable that an aircraft which introduces in one step so many new features should, in fact, prove to be so easy to handle. Everything seems as straightforward as one could wish. One of the aircraft's most important qualities is that, while being easy to fly, it gives the pilots a performance which they have been longing for these many years. At last they can face the Canberra with the sure knowledge that it cannot get away from them—still less be able to indulge in the highly shaming quarter attack on the fighter which has been known to Meteor pilots. Before the Hunter reached the squadrons a number of its handling characteristics took on the proportions of bogies, but when it arrived the bogies did not materialize. Careful briefing, well-learned drill and, above all, happy experience, showed them for what they were.

As already described the between-sortie turn-round is extremely fast and it should, now, be quite feasible to start up for a second sortie only six minutes or so after shutting down at the end of the first. The start-up itself must be sheer joy to the ex-Meteor pilot, there being no trollies, cables, ground/flight switches, or external panels to be attended to. A single ground crewman takes away the ladder and the pilot can taxi out about 20 seconds later.

On a field azure and camouflage a Hunter pilot, gardant, proper; on his helm a cockerel in his pride, rampant, armed.

Taking-off in pairs presents no new problems, and even in a blustering cross-wind, such as was blowing at Wattisham, there seemed to be no difficulty in holding formation at the difficult stage while unsticking. Some of the pairs "hit slipstream," but it was evident that the effect of this is far less than, for example, on a Meteor. And it should not be forgotten that some of the pilots taking part were flying in formation for only the second time.

At altitude (and this now implies levels far in excess of 40,000ft) the Hunter cruises comfortably at a very high Mach number, but battle-formation flying was said to be if anything easier than with the Meteor. "Pitch-up"—another "bogy"—also seems to have made itself conspicuous by its almost complete absence.

Notwithstanding the attachment of the under-fuselage air-brake, the Hunter's flaps are still stressed for high airspeeds and the 40-deg high-lift setting can be used while making a formation let-down at a speed higher than that for a Meteor.

The slow-speed flying characteristics of the Hunter are such that a G.C.A. approach in close pairs is quite comfortable at a very moderate air speed. Particularly indicative of the Hunter's approach characteristics during a normal circuit was the fact that the aircraft demonstrated at Wattisham made a "curved" approach, so much so that some even touched down on one main wheel before the other. After touch-down some pilots lowered their nosewheels on to the runway immediately and began to brake, while others held them, Meteor-fashion, high in the air.

The runway threshold is apparently crossed only 10-15 knots faster than in the Meteor, and the final turn-in is perfectly comfortable so long as the speed is maintained above a very reasonable level. The Hunter's minimum-drag speed is, of course, a little higher in proportion to its stalling speed than that of a comparable straight-winged aircraft. Below this speed, therefore, a great deal of power is required to maintain height and airspeed, but there is enough power available.

All the pilots who flew last week at Wattisham had been operational on Meteors. Their conversion to Hunters had taken the form of three or four preliminary workouts in the simulator (of which more below) and about ten flights in the new aircraft. Even fewer than ten flights, and one or two landings in manual control, are all that is needed before operational working up can start. In fact it was said that, with the average Hunter hours-per-pilot standing at 20-30, the squadrons were already considered operational.

A landing in manual control, incidentally, is yet another of the bogies which did not materialize. Although stick forces are considerably higher it is quite possible to follow the normal circuit procedure with only a slight easing of the final turn-in. Minimum weather conditions for a first flight are considered to be 1,000ft cloud-base and three miles' visibility.

The simulator—one is set up at each new Hunter station—consists of a Hunter forward fuselage mounted on a fixed base, giving a reproduction of the cockpit, complete with ejector seat and all systems, but without gunsight. It is intended to be a systems and procedures trainer rather than a flight simulator and, from a panel mounted on the starboard flank of the fuselage, the instructor can select any of the failures likely to occur in flight. The trainee pilot meanwhile, can go through all the checks and procedures, noting instrument reactions.

The cockpit, as exemplified by this simulator, is one of the best we have seen. A great deal of thought has evidently gone into producing a really logical layout, particularly with indicators close to controls, and these conforming to the latest ideas on the subject.

All in all, then, the Hunter is a tractable, comfortable aircraft, as well as being a mighty defensive weapon. It is heartening to know that, in addition to the units named, No. 222 Squadron, at Leuchars, is fully equipped and that other squadrons including No. 263 (S/L. R. Aytoun, D.F.C.) at Wattisham are converting.

H. F. K.; C. M. L.

TODAY'S RESEARCH for TOMORROW'S TRANSPORTS

Sir Arnold Hall's Brancker Memorial Lecture Continued

Sir Arnold Hall reading his lecture before the Institute of Transport.

"Flight" photograph

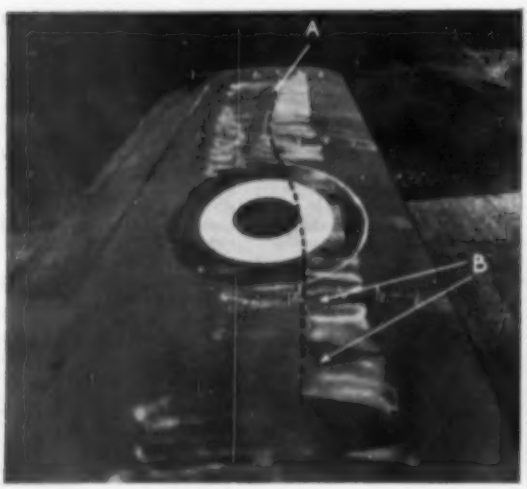
LAST week we reproduced, in slightly abridged form, the first part of the 1955 Brancker Memorial Lecture delivered to the Institute of Transport on February 14th by Sir Arnold Hall, F.R.S., M.A., F.R.Ae.S., Director of the Royal Aircraft Establishment, Farnborough. In these opening sections of the paper—which was entitled *The Influence on Civil Aviation of Some Current Researches*—the lecturer discussed the coming generation of long-range aircraft capable of cruising at high subsonic speeds, and then went on to review the economic aspects of operating airliners at supersonic speeds. Also discussed were possible methods of decreasing approach and landing speeds and of increasing lift. In the following pages are Sir Arnold's remarks on certain aerodynamic aspects of his subject, on structures and materials, on noise, and on navigational techniques; again, his remarks have been only very slightly abridged. Certain illustrations not essential to the text are omitted, but the lecturer's original figure numbers have been retained to facilitate subsequent reference.

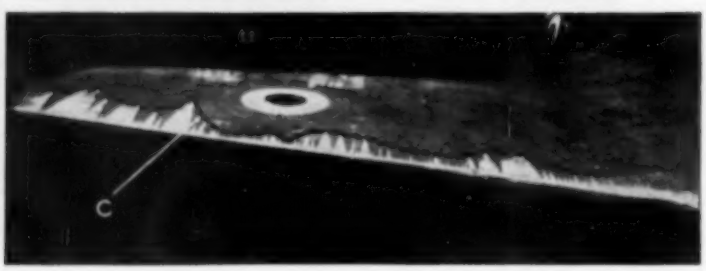
Resistance to Motion: Can it be Reduced?—For many years [continued the lecturer] aeronautical engineers have been tantalized by thoughts of the practical application in aircraft of the discovery, made during the last century, that if, in the region very close to the surface—the region known as the boundary layer—the flow can be maintained in a laminar (smooth) condition, rather than the more usual turbulent condition, the skin friction forces arising from the viscosity of the fluid are greatly reduced.

In recent years we have learned much about the stability of laminar boundary-layers, and on the conditions which must be met if transition to the turbulent state is to be prevented; and by two or three years ago it had emerged that, having in mind the stringent surface conditions (in terms of smoothness and absence of waviness) needed to secure "natural" laminar flow, it was most unlikely that practical application could be made unless the basic stability of the layer could be increased. Fig. 8 (a) shows the extent of laminar flow achieved on the wing of a high-speed aircraft after close attention to surface detail, and Fig. 8 (b) shows the deterioration which occurred after a few hours' flying, due to the roughening of the surface by rain erosion. In these pictures the white patches are areas of laminar flow, shown up by a technique we were able to devise for use in flight.

These considerations led to experiments directed towards increasing the stability of the laminar boundary-layer. Of the several methods proposed, one of the more promising involved making the surface porous so that air could be sucked through it continuously from the boundary layer. Fig. 9 shows an experimental section on the wing of a Vampire aircraft in which such a porous surface and suitable pumping equipment have been installed. By this means we have found it possible in flight to maintain laminar flow over the whole surface. This has resulted in a reduction of the effective drag of the section of wing concerned to about a quarter of its initial value, taking account of the pumping power. Typically, the actual drag of the section is reduced to one-tenth its initial value, while the pump power needed to achieve this result is equivalent to about one-sixth of the initial wing drag. The quantity of air which must be sucked through the surface is very small indeed; typically, the velocity through the porous surface is 3 in/sec. We found, however, that this result could still only be maintained with careful attention to smoothness and lack of waviness in the surface—though there are easements compared with an "unsacked" surface.

Meanwhile, it was established that it is much more difficult to maintain laminar flow on a swept-back wing than on a straight wing. Meanwhile, also, the advances leading to the possibility of the long-range high subsonic aeroplane discussed in Section 1 had steadily made it more certain that a competitive aeroplane of the next generation must cruise at speeds of the order of





Experiments in laminar flow: Fig. 9 (right), a porous sleeve over the wing of a Vampire for suction experiments; Fig. 8a (below), port wing of Hawker N.7/46 showing (A) limit of laminar flow, and (B) typical turbulent wedges from surface imperfections; Fig. 8b (bottom right) starboard wing, showing (c) sensitivity to surface condition.

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TODAY'S RESEARCH FOR TOMORROW'S TRANSPORTS . . .

500 m.p.h. and that, even without laminar flow, distinct economies as compared with present-day aircraft are possible.

It is always difficult to draw general conclusions on the probable influence of such an effect as "laminarization." I have therefore attempted an economic analysis of the influence it might have on the specific case of civil aircraft capable of the London-New York non-stop flight, carrying 120 passengers. The datum aeroplane has a straight wing with no laminar flow, and is designed to make the London-New York journey at 500 m.p.h. The design is then varied, on the assumption that laminar flow is achieved on a substantial part of the wing—producing about 20 per cent reduction in the viscous drag of the aeroplane—and then that it is achieved on the whole aircraft surface, producing about 80 per cent reduction in the viscous drag. This latter would be a most formidable design problem to achieve by suction, and the purpose of the case is to suggest the ideal upper limit of economy rather than a practical possibility. The cruising speed is maintained at 500 m.p.h. throughout the variation. As the drag is changed, the take-off and landing performances of the aircraft vary, and the design has been adjusted to bring back first the take-off of the datum machine and then the landing performance, and finally both. This is achieved by an appropriate adjustment of the wing area, and by the use of "take-off only" engines where necessary. This is done because, when the viscous drag of the aeroplane is reduced, so also is the installed power needed for cruising flight, and an aircraft emerges which is underpowered, by its propulsion engines, for take-off. The results of this analysis are summarized:

TABLE IV

	Datum aircraft	Same take-off as datum a/c.		Same landing as datum a/c.		Same take-off and landing as datum a/c.
		Landing deteriorates →		Take-off deteriorates →		
Reduction of viscous drag (per cent)	0	20	80	20	80	80
Take-off weight (lb)	228,000	215,000	158,000	230,000	162,000	170,000
Formula direct operating cost (pence per capacity long-ton nautical mile) ...	10	10	7.7	10.5	7.5	8

NOTES: All aircraft cruise at 500 m.p.h., London to New York non-stop, carrying 120 tourist passengers. To obtain total operating costs, the "in practice" element, and the indirect element (see Table I, Pt. I) must be added.

Any assessment such as this is at the mercy of the assumptions made about the weight and cost of suction equipment, and the increased first cost and maintenance cost of the airframe arising from the use of porous surfaces. The assumptions used in this case—mentioned in Appendix I [given last week—Ed]—are not, I think, likely to be so unreasonable as to make the result seriously misleading. The factors which are influential in producing the result are these. There are, first, the demands of reasonable take-off and landing performance. Next, though for a given payload the weight of the laminar aeroplane is less than that of a conventional machine, the prime costs and corresponding annual charges are less reduced in proportion than are the weights, owing to the provision of the porous-surface feature. Unit maintenance costs are likely to rise. The item showing substantial saving is the cost of fuel, which reflects the reduction of drag achieved.

I conclude that, on economic grounds, there is little to be gained from "laminarization" of aircraft of the "London to New York non-stop" type, unless much more of the surface than the wings alone is treated. Were it possible to "laminarize" the whole surface, a not insubstantial saving of direct cost would be gained, but I have doubts about the practicability, in engineering terms, of achieving this. This is not to say that laminarization may not find application, perhaps in ultra-long-range aircraft, but its chances do not seem good for the next generation of long-range civil machines. Plainly, it will find its most effective applications where the fuel costs are a high proportion of the direct operating cost.

The Structural Field.—In civil aircraft, for some time to come, it is unlikely that there will be any move away from the use of aluminium alloys for structural purposes, unless it be to the use of plastics; at supersonic speeds, up to twice the speed of sound at least, aluminium alloys will retain their attractions. If there is a competitor to aluminium for such structures as fuselages, it is glass. Glass-fibre-reinforced plastic is easy to form to shape on simple tools, an important consideration for civil aircraft, particularly of the larger sizes, where the total production needed will not be very large. A fuselage so formed would not be heavier

Fig. 12. The gust-recording fatigue-meter developed by the R.A.E. (and made by Mechanism, Ltd., Croydon). The "windows" show the cycles at 0 g, 0.4 g, 0.7 g, 1.3 g, 1.6 g and 2 g, respectively.

than one made of aluminium alloy, would probably be cheaper, and would probably be free from the problems of fatigue . . .

The fatigue properties of metallic materials used to sustain a dynamic load system are often the factors limiting the working stress level, rather than the ultimate strength of the material. Aircraft receive repeated or oscillatory loading from, for example, encountering gusts, from landing loads, and from the rise and fall of pressure within the cabin (relative to the external pressure) during climb and descent.

In recent years we have been able to acquire a great deal of information on the distribution and intensity of gusts, from counting accelerometers installed in aircraft flying all over the world. These instruments count the number of times a series of levels of vertical acceleration are reached.

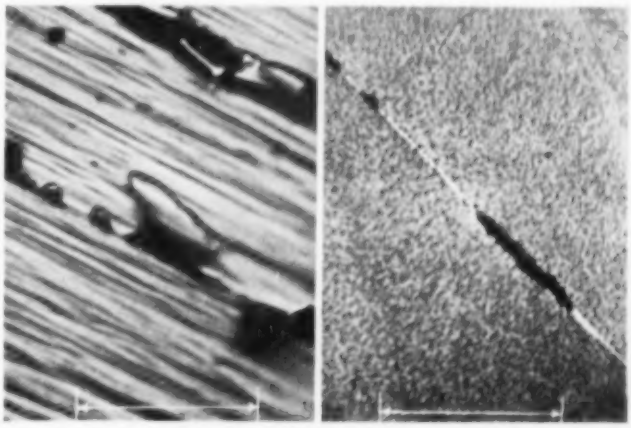
Recent experience has demonstrated the need, for the present at least, for exposing complete aircraft to a fatigue test, in which the mean static loads are applied to the machine, whilst the equivalent oscillatory and repeated loads are applied to the wings and pressure cabin. It is on the basis of the information acquired in the gust surveys mentioned above that we are able to apply realistic oscillatory loads, and interpret the results in terms of flying hours.

We have recently developed a gust fatigue meter (Fig. 12) to be carried in civil aircraft, which records the loadings experienced by the aircraft due to gusts, and which will act as a guide to the replacement of "fatigue-worn-out" parts (particularly in the wing structure) on a basis of the actual experience of the particular machine rather than the average experience of the type; thus some maintenance economies, consistent with safety, should be possible compared with present practice.

We have made some interesting discoveries recently while working on fatigue in aluminium alloys, and this has led us to a tentative theory of the origins of fatigue which may help towards the development of alloys with improved properties.

We have vibrated small polished specimens electro-magnetically, and made microscopical examinations of them. We have found

Fig. 14. Phenomena occurring in the fatigue process; 14a (left) exudation between slip-bands in Al with 4 per cent Cu; 14b, crack progressing along region weakened by exudation. The inscribed white lines are in each case 0.001in apart.



TODAY'S RESEARCH FOR TOMORROW'S TRANSPORTS . . .

that, under repeated loading within the elastic limit as ordinarily understood, slip occurs in the crystals of the material.

We have been able to observe a number of metallurgical changes taking place in the alloy before fatigue cracking occurs. One of these is the exudation of thin metallic ribbon from the crystal surfaces as shown at a magnification of 1,500 times in Fig. 14 (a). These ribbons leave a crevice in the surface which may subsequently develop catastrophically. Fig. 14 (b) shows a crack caught in the act of proceeding along such a region.

It is well known that, in aluminium alloys, high temperature promotes precipitation of the alloying atoms, and produces a soft matrix of practically pure aluminium in which are embedded large aggregates of the precipitates. One explanation of the exudation phenomenon induced by repeated loading is that the slip produced in the crystals causes local high temperatures, which in turn cause local precipitation of the alloying atoms. The soft spots so produced are then extruded under the action of the alternating stress, and the crevice is formed, causing stress concentrations, which excite the phenomenon further, so extending the crevice, which eventually becomes a fatigue crack.

If this explanation be correct, a higher fatigue resistance could result were it possible to choose alloying constituents which will not precipitate under these circumstances.

Noise from Aircraft.—In this section of his lecture, Sir Arnold Hall began by discussing the differences in noise made by airscrew driven and jet propelled types of aircraft respectively. As cruising speeds are increased [he said], it is desirable to reduce the rotational speed of propellers in order to avoid loss of efficiency, and it is likely that at take-off the external noise of high-subsonic propeller-driven aircraft will not be greater than that produced by present-day types. The noise in the cabin whilst climbing and cruising may well be a problem, because much of the noise generated by a propeller comes from the low-frequency components of the rotating pressure-fields which are produced as the blades rotate, and such low-frequency sounds are not greatly attenuated by sound insulation; their control to reasonable limits is likely to involve an appreciable weight penalty in soundproofing.

Recent mathematical investigations which we have made have suggested that the noise may be significantly reduced by changing the distribution of the thrust along the blade from that at present used, putting more of the load towards the root. A reduction of noise by about 5 decibels seems to be possible by this means. The resulting blade may well be more difficult to manufacture than existing types, but there would be a substantial reward.

The sources of noise from a jet, as suggested by mathematical work by Professor Lighthill, of Manchester, can be described in rough terms as follows. From a subsonic jet, there is a high-frequency component of noise, which has a directional maximum of about 45 deg to the axis of the jet; the frequency of the sound is about $0.7\frac{U}{d}$ and more (when U is the velocity of the jet, and d its diameter) a typical figure being 500 cycles per second (1 octave above middle C) or above. In addition, there is a low-frequency component, which has a directional maximum mainly along the direction of the jet; the frequency is about $0.3\frac{U}{d}$ and less—typically 250 c.p.s. (middle C) and below. If the jet is supersonic—as it is likely to be during the climb and cruise—there is, in addition, a further component with a directional maximum about 100 deg from the jet axis. All three are highly directional.

The high-frequency 45 deg sound arises from the highly sheared regions at the edge of the jet, where violent mixing is taking place between the jet and the surrounding air. The low-frequency, along-axis sound arises from the turbulence within the jet itself. The additional sound at 100 deg from a supersonic jet arises from interference between the eddies and the standing shock-waves in the jet.

The intensity of the noise is proportional to the eighth or higher powers of the velocity—if the velocity is doubled, the noise increases at least 250 times. It will, therefore, be beneficial to use engines such as the by-pass type, which for a given thrust produce a lower jet velocity than the simple turbojet.

It has been found that useful reductions of jet noise can be obtained by inserting "fingers" into the jet at the lip of the jet pipe, or by using a pipe corrugated around its tip. These devices probably affect the noise by causing a spreading of the jet, so that the velocity is reduced more rapidly with distance downstream than would be the case in their absence, with the benefit to noise generation represented by the "eighth power of the velocity" law. In addition, they probably tend to reduce the directionality of the noise, so reducing the peaks of intensity.

Navigation and Communication.—In introducing this section of his paper the lecturer remarked that the elimination of accident due to impact with terrain, and accident or discomfort due to entering intense storm, would be considerably assisted by the use of micro-wave radar in civil aircraft. Suitable equipment, operating on a frequency high enough to obtain good echoes from storm centres, was now becoming available. Such aids, together with long-range radio navigational facilities of increased accuracy, should eliminate accident due to navigational error and storm.

A recent development in communication equipment which we have been able to make [he continued] may prove of value to civil aviation. The traditional system for communication over distances more than a few miles has been manual telegraphy in the 3 to 30 mc/s band. Radio telephony, with its advantage of being available for direct use by the pilot, rather than through a radio operator, has only recently been relied upon by some airline operators, using more powerful amplitude-modulated equipment, identical in principle with domestic broadcast equipment, than has hitherto been available. We have been experimenting with a system of a different type, which uses transmission on a single sideband. The work has shown that considerable improvement is obtained by this means, as compared with the performance of conventional equipment, the frequency of successful message transmission under difficult conditions being three times improved. . . .

In the ordinary amplitude-modulated transmission, the carrier wave conveys no information, and the pair of sidebands duplicate the message. By suppressing one sideband, the band-width needed for the transmission is halved, and the probability of jamming by other signals is correspondingly reduced. Signal-to-noise ratio is improved, there is absence of selective fading, and improved intelligibility at low signal to noise ratios. The penalty for these features lies mainly in the need for considerably improved frequency stability in the transmitter and receiver, but this requirement is within the performance of mass-produced crystals, provided they are temperature-controlled.

The Landing Operation in Bad Weather.—The basis of the technique which has been evolved, and is now widely used, for low visibility, or low cloud-base, landing is this. The aircraft makes an approach to the runway down an approach path which is defined for the pilot either by a radio-beam (I.L.S.) or by verbal directions from the ground, based on the observation of the aircraft by high-precision radar (G.C.A.). The runway is equipped with the cross-bar lighting system, which we introduced a few years ago, and which has proved itself capable of giving the pilot the visual data on which to position himself for his final approach and touch-down. The geometrical layout of this lighting system is shown in Fig. 17. The pilot changes over from the I.L.S. or G.C.A. system to the cross-bar lighting system, thereafter completing his landing visually as soon as he has adequate visibility of the lighting system; but if he has not acquired this visibility before he comes down to a particular altitude known as the "critical height" he breaks-off his approach to the runway, and flies over the airfield, thereafter awaiting an improvement in visibility or making a landing at an alternative airport. The break-off height is determined for each type of aircraft to ensure that a safe "fly-over" can be made. The pilot is informed, before starting his approach, of the "runway visual range," this being a measure

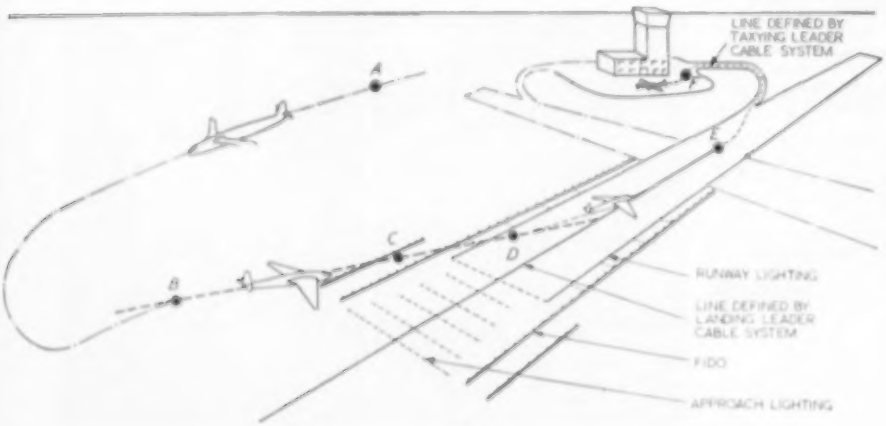


Fig. 17. Phases of the approach and landing manœuvre: A-B, inbound leg (manual, or automatic height control and auto-direction from I.L.S.); B-C, final leg (manual on I.L.S. or G.C.A. information, or auto approach or approach coupler); C, critical height (transition zone); C-D-E, landing phase (manual, based on vision aided by approach and runway lighting and Fido, or auto-landing based on such system as leader-cable); E-F, taxying (vision or leader cable).

of the visibility along the runway from the point of touch-down; and should this be too low for safety he will not, of course, start his approach at all. It is a particular feature of the cross-bar lighting system that it provides the pilot with the visual guidance he needs to correct his lateral position, assisting him in separating the effect of bank, and lateral displacement from the centre line, which, when viewing a single line of lights, produce a similar visual impression, but a very different sequence of movement.

The factors which have had a radical impact on the all-weather landing problem in recent years have been the increased precision possible in the radio beam, and ground radar, and the introduction of the cross-bar lighting system. These advances have allowed the development of safe landing techniques for weather down to "runway-visual-range" visibilities of about 500 yards. Abortive approaches, however, are not rare in conditions near the lower ranges of visibility, and the reason for this is not far to seek. It is that the "runway visual range," though the best criterion readily available . . . is nonetheless misleading in some cases as a guide to the slant range at which the pilot will be able to acquire a full visual grip on the approach lighting system.

Recent advances in radio and instrument technology will provide further improvements in the accuracy of definition of the approach path, and will supply the pilot with simplified indications to assist him to fly the path accurately. They will also provide the means of so coupling the signals received in the aircraft from the approach beam radio transmitters to the automatic pilot that the aircraft can fly automatically with precision and reliability down the approach path. I will not consider these advances in further detail save to remark that they will enable civil operators to work safely and reliably down to the minimum visibility needed to permit a safe visual landing to be made; I will, however, discuss how we may hope to take the matter further.

There are two approaches to the problem, the first to provide such assistance to the final phase of "flare-out and touch down" —the phase below the critical height—that it is made without reliance on visibility. The second is to increase the visibility for touch down by dispersing fog. It may well be that a combination of both will provide the eventual solution. As a complement to a solution, means will be needed to enable the aircraft to taxi safely on the airport in bad visibility—there is no point in achieving a landing only to become lost in the fog on the open area of the airport.

In Fig. 17 is illustrated an airfield equipped with a number of devices with which we have experimented recently. I must say immediately that this airfield does not exist, for the experiments of separate components have been made in separate places, but the results are nonetheless valid. I will divide the equipment into these categories, to be dealt with separately: The automatic landing element, the fog-dispersal element, and the taxying element.

The Automatic Landing Element.—In an experimental equipment with which we have made automatic landings the airfield is equipped with the I.L.S. radio beam system to define the approach path, and with a leader system, carrying an alternating electric current, as indicated in Fig. 17. The aircraft is equipped with an automatic pilot, into which the I.L.S. signals are fed, and which guides the aircraft down the approach. On reaching the critical height, control of the automatic pilot is transferred from the I.L.S. radio beam to elements in the aircraft which, deriving their information from the magnetic field of the leader cable system, land the aircraft automatically. The system lands the experimental aircraft with a vertical velocity at touch down and with an error in positioning relative to the centre of the runway which compares favourably with the performance of skilled human pilots working in good visibility.

There is no doubt that, for civil aviation, the step from using I.L.S. or G.C.A. approach, followed by visual landing, to the use of an automatic system such as this would be a major one, involving the most careful consideration of reliability and safety. I do not think that the "state of the art" is such that it is ripe for such a change yet—though considerable progress has been made in ensuring the reliability of the equipment and in making sure that, if it fails, it "fails safe."

The Fog-dispersal phase.—During the late war the remarkable fog clearing device known as Fido was developed, and it proved itself capable of greatly facilitating landings in quite thick fogs. It was a fine achievement of the Petroleum Warfare Department, and it is no criticism of that achievement to say that the system was so costly to operate for short runs that when viewed against a background other than that of war it was unable to serve a civil need. . . .

We have been trying to produce a system which uses a cheap fuel, which can be started and stopped very quickly, and which is controllable in intensity of burning so that the fuel consumption is no more than the particular fog condition demands. These aims have been largely achieved in a system which operates on gas-oil. Atomising burners have been developed which can be opened-up without a preliminary warm-up and which cut-off immediately on shut-down. Each burner head has three atomizing nozzles of the swirl-chamber type, operating from a fuel line at 1,000 lb/sq in pressure. The burner heads are set in slotted plates mounted in concrete pots so that they can be used at runway intersections without causing interference to aircraft using the intersection when the system is not operating. In the part of the installation ahead of the threshold of the runway the burner can readily be mounted on riser pipes at heights to suit local conditions. Control is obtained by grouping the burner heads in lines of three, fed by two main feed-lines, one connected to a single burner in each group and the other to the remaining pair. Output can thus be reduced by one-third, or two-thirds, by simple valving. Rapid-action spring-loaded cut-off valves are fitted between each burner and its supply line, to ensure that there is no spillage of fuel when starting or stopping. Ignition is by means of heater-coil igniters. This system gives a very clean flame which provides about 30 therms per yard per hour on about 18 gallons of gas-oil per yard per hour.

The stage has now been reached at which the economics and effectiveness of this system can be assessed by practical test; a complete installation is to be made at an airfield, for trial. Should such a system prove reasonably economical for use in civil aviation, the visibility at which routine visual landings could be made off I.L.S. or G.C.A. would be very substantially lowered. Were this done, a system permitting taxying on the ground subsequent to landing would be desirable, and one such system is described in the next section.

The Taxying Phase.—We have made some experiments in the use of a leader cable installed in the taxi-track as shown in Fig. 17 to direct the movement of aircraft on the ground in conditions of bad visibility. The aircraft carries equipment for receiving magnetic signals from the cable, as in the automatic landing equipment. These signals feed a pilot's indicator showing displacement from the centre line of the taxi-track, and deviation from "correct" heading, the "correct" heading being such that, when the aircraft is displaced from the centre line, and it is put on, and kept on, correct heading, it approaches the centre line exponentially. In aircraft equipped with a steerable nose-wheel, there will be no difficulty in arranging for automatic steering.

In a complete airfield installation, the leader cable could be switched in sections in order to guide the aircraft along one of several alternative tracks. Used in conjunction with a micro-wave surveillance radar, which would show the position of all aircraft and vehicles on the airfield, it could provide mobility in dense fog conditions.

Where Will This Take Us?—The experiments I have described at least show that progress can be hoped for in reducing the effect of bad visibility on regularity of operation. I have no doubt that other methods may emerge. Indeed, the developments in ultra-high-frequency radio transmission are such that the replacement of several of the devices I have mentioned above by what might be described as "radar-television" is by no means impossible. Such a system might eventually be capable of providing a picture of the airfield ahead of the aircraft to a fineness of detail only a few times poorer in resolution than the impression gained by eye. If this proves to be the case, the pilot might well be provided with a synthetic picture of what is before him which is sufficiently little different in the essentials from what he normally sees by eye that he could make a landing without other aid.

There can be no doubt that, whatever system is used for bad visibility operation, the task of the system and of the pilot is rendered easier as the approach speed of the aircraft is lowered. The gain of ease and safety with drop of speed is, I think, a very rapid one. Most of the critical issues are matters greatly affected by "time available" for decision and action or for automatic mechanisms to do their work. The wisdom of using some of the technical advances available in aircraft design to lower approach speed, rather than to take the "last ounce" on economics in the cruising phase, will be well repaid by greater regularity with safety. If we are to achieve what we should seek in bad weather operability, the task should not be left entirely to the instrument and electronic engineer; a contribution from the aeronautical engineer, in terms of lower fully controlled approach speeds, is needed.

Conclusion.—Many of the possibilities before us are exciting —aviation will continue to move fast. The engineer is sometimes accused—sometimes rightly, sometimes wrongly—of wanting the new when the consolidation of the old would be wiser. The civil aviation scene needs some of both. In the long-range field at least we need new breeds of aircraft to provide the economy and service the passenger needs, and the possibilities are before us, but we must eliminate the not entirely incorrect idea that aviation still has some hazards. This is the major matter to be borne in mind when capitalising the newer possibilities. It is to this that attention must be continuously directed, and if we have an eye on the distant possibilities—as it is right that we should—we should nevertheless see to it that the fullest use is made at the earliest opportunity of those things which make for a safe, reliable journey at a reasonable price.

TV FILM FINALE: DREAM OR NIGHTMARE?

ENTITLED *Past and Future*, the last episode in the Television film *War in the Air* formed a brilliant, self-contained *finale* to the series. Introduced by Sir Philip Joubert, it reviewed military aviation development from World War I to the present day. Shots of Sopwith Camels and Handley Page 0/400 bombers taking off, an impeccable formation of Hawker Furies at a Hendon Air Display, the stressing of the "fatal mistake" of the Germans in 1939 in failing to build up a long-range strategic bomber force; these were highlights in a series of all-too-brief flashbacks. Then, in 1945, an event "multiplied the whole force of air power a million times in a single blinding flash"—the first atom bomb was exploded. In 35 years air power had grown into a potential destroyer of the world. This whole development had taken place during one generation—in the lifetime of men not much advanced beyond middle age.

The atom bomb, together with the gas turbine and guided missiles, viewers were told, appeared as three entirely new factors in 1945. The new outlook brought by the atom bomb was stressed and the difficulties of adequate Civil Defence briefly commented on. If a country such as Great Britain was to survive in a future war, every one of the enemy bombers employed in an attack must be brought down. The cost of *even one* getting through to drop its load would be too immense.

One thing and one thing only might make such 100 per cent defence possible—the guided missile. Shots of British and American rockets being launched and of Nike missiles tracking and bringing down a Superfortress added weight to this hope.

The Rolls-Royce "Flying Bedstead" was shown airborne in one of a series of shots depicting post-war aircraft, and the comment made that we were "still in the Wright Brothers stage of this new aviation."

The film brought in construction by NATO of air bases throughout the Western world to build up defensive air power as a deterrent to possible aggression. Strategic bombing—or the threat of it—was, in the words of the commentator, "still the greatest known weapon."

In its closing sequences the film gave more material for thought. A V.2 was shown taking off, its possible use with an atomic warhead being mentioned; and a contrasting sequence covered the recently inaugurated S.A.S. route over the North Polar regions. Whether this is the forging of a "new link" or the "last battleground" is something which only time will tell; but one thing is certain—the final answer lies not in the hands of the scientists producing the weapons, but in the hearts of ordinary people, such as the readers of this review.

And so, after nearly four months, the series—the second attempt to record one aspect of contemporary history in a novel and dramatic manner—comes to an end. What is the overall impression of the film?

Technically, the general accuracy was high. There were very few instances of those relatively unimportant, yet annoying, shots depicting the wrong type or mark of aircraft; this was due, no doubt, to the fact that each film had been scrutinized by people from the Central School of Aircraft Recognition before screening. A severe handicap in the production of the series, however, had been the lack of suitable material to cover certain aspects of the air war—particularly the early days, when few cameramen had been allowed to fly. In at least two instances, one where it was desired to show that Wellingtons were used during a particular campaign and the other where Meteors were shown going into action against flying bombs, the choice lay between showing the wrong mark of aircraft or no aircraft at all. The decision to use shots of the wrong mark may, in the words of the B.B.C., have "enraged the super-critical specialist"; but it was thought justifiable because the film was produced primarily for the rank-and-file viewer. Even so, one feels that these departures could easily have been covered in the commentary and the factual accuracy of the series maintained.

That such minor inaccuracies did not deter people from looking in, however, is evident from the B.B.C. Listener Research figures of over ten million viewers each week for the film—the total viewing population.

The main fault of the series, in the opinion of the writer, was not the inclusion of the many continuity and "atmosphere" shots, but the exclusion of important operations, which could have found their place had each episode been a little longer. The "playing down" of the Japanese Kamikaze operations was apparently deliberate because these had been covered in some detail recently in the earlier American film, *Victory at Sea*; but it seems inexcusable on these grounds, for the omission left a serious gap in the air story, considerably reducing the obvious historical value of the series. The virtually complete omission of any reference to German jet and rocket developments, excepting an all-too-brief episode on V.1s and V.2s, was another major fault detracting from the value of the series as an historical record.

There seems to be no particular reason why the series was limited to 15 episodes, though this is, in fact, three more than was originally planned. A weekly audience of ten million is surely proof enough that the B.B.C. under-estimates interest in such a subject. It is probably true, as the B.B.C. explains, that, however long the series was, there would be the specialists who would have liked it that little bit longer; but the series as shown seems to have been too short even for the majority of ordinary viewers.

A noticeable feature was the lack, with one or two exceptions, of really spectacular sequences of aircraft in action. The earlier *Victory at Sea*, primarily covering the sea war, managed to include many more really breath-taking shots of aircraft. The series also included too few shots depicting enemy activity and clear explanations of his counter measures as the Allied air onslaught mounted in intensity. Many viewers will have known about, and some taken part in, the story from the Allied side; and more film from enemy cameras would have given one the impression of being privileged to see what went on behind the scenes and enemy lines during those momentous years. But even if the general public is still little wiser regarding the impact of air power on world affairs—apart from the fact that if you drop a lot of bombs you do a lot of damage, or if you smother a small ship or train with machine-gun fire it disintegrates—the end of the series will leave many viewers wishing for a programme of equal interest on Monday evenings to come.

M. F. A.

JANE HERVIEUX—AN APPRECIATION

THE recent death of Jane Hervieux, the great pioneer airwoman [writes Norman R. Morrow-Tait] must have revived nostalgic memories to all those whose interest in flying goes back to an earlier era.

Jane Hervieux was not the first woman to fly alone, as stated in many of the newspaper obituaries. This honour belonged to her friend, the beautiful Baroness de la Roche, who was also the first woman in the world to gain a pilot's certificate—in March, 1910. Mlle. Hervieux was the first woman in the world to take up flying as a profession, learning under the great Louis Blériot at Mourmelon in the spring of 1910, and gaining her certificate at Pau in December 1910 under the tutelage of Blériot and Leblanc.

On December 31st, 1910, Jane Hervieux made a magnificent flight of 2hr 2min at Pau on a 50 h.p. Gnome-Blériot monoplane, being chaired in triumph on landing by Jules Vedrines, Beaumont and Lemartin—names soon to become world famous in aviation. She continued to give exhibition flights on a Blériot on the Continent until the outbreak of war in 1914. Pegoud himself taught her to loop, and she made many long-distance and height records for women flyers in the days when aircraft were mainly constructed of wood, wire, and fabric.

During the 1914-18 war Jane Hervieux ferried aircraft from place to place behind the lines and for this work was granted the honorary rank of captain in the French Air Service, the only woman to be so honoured at that time. Nungesser, one of the great aces of the war, taught her advanced aerobatics, so she was well equipped to continue her professional career in aviation when civil life restarted after the Armistice.

In Paris, in the spring of 1919, I well remember Capt. Jane Hervieux giving exhibition and passenger flights on a tiny G.3 Caudron. I was only a boy at the time but clearly recollect that it was then quite the fashion to sail over Paris with Jane Hervieux in her biplane; she must have given hundreds of passengers their baptism of the air 36 years ago.

After the death of her friend the Baroness de la Roche, in a flying accident in July 1919, Capt. Hervieux went to America to become chief pilot of the Curtiss School of Flying on Long Island, New York—the first woman to take over the duties of an instructor. She gave lessons to Miss Amelia Earhart, later to become world famous as the first feminine Atlantic and Pacific flyer, and also taught many of the New York State Police Air Squadron to fly.

In 1920-21 Capt. Hervieux made a flight in stages from New York to Florida and on to Cuba in her Curtiss aircraft, also giving exhibition and passenger flights at many towns on the way. She married Mr. Philip Catalano in America in 1922 and had lived in London for many years.

Jane Hervieux was a wonderful pilot and her skill and daring in the early days of flying did much to blaze a trail for all the famous women pilots who followed after her. She had the admiration of all who remember the old flying days.

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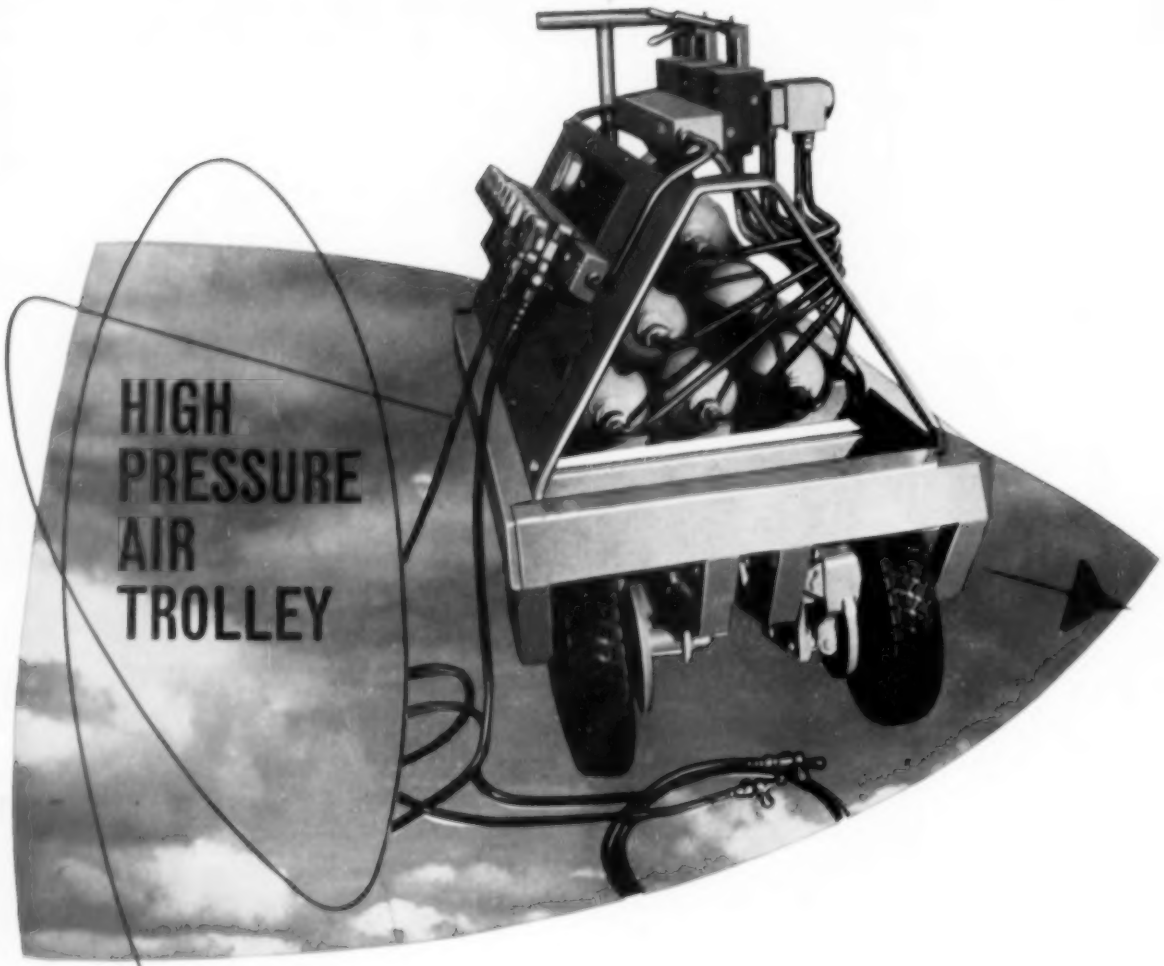

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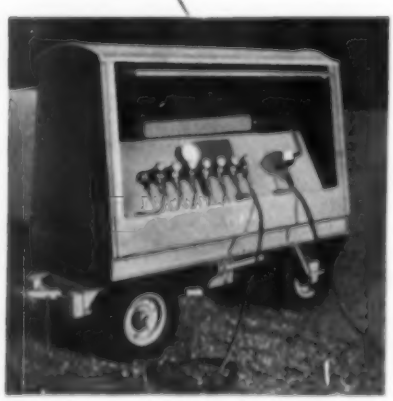
Provision is made for charging or discharging the bottles in pairs, enabling any pair to be used separately or in combination.
A charging point is provided.
All the equipment is mounted on a steel chassis, fitted with pneumatic tyred wheels, parking brake and telescopic draw bar.
A metal canopy, with a sliding side panel giving access to the control valves, enables the trolley to be used out of doors under most weather conditions.



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CORRESPONDENCE

The Editor of "Flight" does not hold himself responsible for the views expressed by correspondents in these columns; the names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

The Short Cockle, referred to in letters below.

"After the Storm"

YOUR leading article of February 4th introduced some very important matters for consideration. The fact that (so far as I am aware) the proposals are largely new may, with respect, indicate that under present arrangements rescue helicopters are nobody's baby, rather than that your suggestions have not been thought of previously

Certainly, we should not *have* to depend upon the fortuitous availability of British and American helicopters to carry out rescue and other emergency work. The police, to their credit, have shown some active interest in the potentialities of the helicopter —but only, I believe, for the primary, robber-catching side of their work.

As a start—perhaps to lead up, eventually, to a National Helicopter Rescue Organization—it would be well worth considering the possibility of attaching a helicopter and pilot to each of a few R.N.L.I. stations at key points around our coast. The helicopters could work in conjunction with the lifeboats when weather conditions permitted, and could often bring first aid before other ships could get to the scene of an emergency.

Between times, there are many daylight jobs which the helicopters could undertake to help earn their keep. I have in mind ship-to-shore taxi work, supplying lightships, preliminary aerial examination and survey for local authorities, air photography, crop inspection for farmers, co-operation with the police on traffic problems, and over-water taxis for "officials" in riverside cities like Southend, Southampton, Plymouth, Bristol, Liverpool and Hull, to mention but a few.

Birkenhead, Cheshire. A. W. THOMS.

Light Flying-boats

WITH reference to correspondence on the subject of ultra-light flying-boats, may I draw attention to a worthy contestant for the title of the world's smallest flying-boat?

I enclose for your interest two photographs [one is reproduced above—Ed.], which I obtained from Short Bros. and Harland, of the Short Cockle, a most intriguing aircraft unheard of by most people. The photographs appear to have been taken on the Medway at Rochester, and I have heard it said that the Cockle had a cruising speed of about 65 m.p.h.

I am not aware of the aircraft's physical dimensions, but believe that two Blackburne Tomtit power units were employed. I have seen these engines quoted at different sources as being 26, 24 and 18 h.p. These horsepower figures appear somewhat legendary, and probably the more appropriate comparison could be drawn from their cubic capacity, which was supposed to be 696 c.c. The engines drove tractor airscrews through extension shafts and were hand-started from a lever in the cockpit.

I would suggest that this boat was constructed about 1924, although the registration (EBKA) will doubtless serve to clarify the issue. My own information on the machine is very sketchy, and I would be only too pleased to hear from anybody with more accurate details of its specification and history.

Ashford, Middlesex. AUSTEN CHAMBERLAIN.

SURELY the Short Cockle is worthy of mention? I do not remember the dimensions of this machine, but when it was built (about 1924) it was fitted with two 6 h.p. Blackburne vee-twin motor cycle engines. It was successfully flown by Mr. Lankester Parker and, after being subsequently re-engined with two 18 h.p. Bristol Cherubs, was painted with Service markings and delivered to the R.A.F. experimental station at Felixstowe, where it was flown by S/L. B. C. H. Cross.

This machine was fitted with an all-metal hull—quite a novelty in those days.

Another interesting little flying-boat that was built a few years later was the Dornier Libelle—also all metal, but fitted with an engine of about 40 h.p. GEORGE W. GREEN.

Surbiton, Surrey.

[Both the Cockle and the Libelle were *relatively* large aircraft. The span and length of the Cockle were 36ft and 24ft 8in, and the corresponding figures for the Libelle were 32ft and 24ft 5in. In Mr. Chamberlain's letter the suggestion is made that the Cockle was "unheard of by most people"; but older readers of *Flight* may recall a detailed description and numerous references.—Ed.]

Deck-landing Floatplane

THE two photographs on the Correspondence page of your issue of February 11th, showing the Swordfish aircraft fitted with floats landing on H.M.S. *Ark Royal*, are undoubtedly of the aircraft belonging to *Resolution* flight.

The aircraft was carried on a catapult fitted on top of "X" turret on H.M.S. *Resolution*. At the outbreak of war the aircraft was attached to H.M.S. *Resolution* on convoy duties across the Atlantic to Halifax, Nova Scotia, later going to Narvik and Tromsö in Norway, where many dawn and dusk patrols were carried out from the fjords, also spotting for the 15in guns of the battleship when lying off Harstad. On one occasion, I believe, the C-in-C., Admiral of the Fleet the Earl of Cork and Orrery, was catapulted off.

Later the battleship went to the Mediterranean and took part in the battles of Oran and Dakar and the first Malta convoys, the aircraft carrying out spotting and anti-submarine patrols. When the ship was tied up to the mole at Gibraltar the aircraft continued to fly from the harbour on leaflet raids on Casablanca, etc., and carried out height-finding exercises at night over the Rock for the searchlight crews.

After the landing on the *Ark Royal* no damage to the floats occurred that a little liquid marine glue would not fix.

The crew during these difficult but very happy days were Lt. M. W. Watson, R.N. (pilot), Midshipman Grant (observer) and Ldg. Airman Panton (telegraphist/air gunner).

Portsmouth. C. J. ATKINSON.

Mudros Memories—From Australia

THE issue of *Flight* for November 12th, 1954 (page 725), showing the Sopwith Triplane N5431 at Salonika, prompts me to suggest that either this was rebuilt after the crash referred to, or another one showed up at Mudros in mid-1918. As an armourer rating in those far-off days, my duties were, in what later became 221 Squadron R.A.F., concerned with Camels, D.H.9s and D.H.9As. I remember the "venetian blind" attracting attention by being stunted around in C Squadron, No. 2 Wing, but who this pilot was I do not recall. There was, however, a pilot named Grey whom I saw take off a Camel and loop it immediately, with but inches to spare!

References to Alcock remind me, too, that there was, at Mudros in 1918, a composite aircraft—virtually a cross between a Pup and a Nieuport—known as the "A1." I believe it had been designed by Alcock. I recall, too, that it was crashed and written off by a F/L. Nightingale, who later was lost in a D.H.9 from Stavros. DON. B. KUOCK.

Randwick, Australia. (Capt., 2nd A.I.F., Ret.)

Flight Test Observers' Association?

IN this era of pressure cabins and power controls the flight testing of aircraft has become so complex that the pilot almost invariably takes with him one or more flight test observers. Recently the numbers and responsibilities of these men and women have greatly increased, and I feel that in some way an association should be formed amongst them. May I beg the hospitality of your columns to explain this project a little further?

I have sounded some of my colleagues, and they are fully in favour of the idea. Suggestions include the name of "The Guild of British Flight Test Observers," and that all civilians employed as aircrew observers on pre-user test flights should be eligible to join.

Some of the aims of this organization might be to assist the dependants of flight test observers killed or injured whilst test flying; seeing that adequate flying and safety equipment is provided; promoting social functions among observers; publishing a monthly journal; informing the public on matters concerning flight test observers; and exchanging general ideas and opinions.

I must emphasise that I am writing this letter in a purely private capacity, that the official and legal aspects have not yet been examined, and that there is no intention of forming a "union" in the normal sense. Should any of your readers be interested in the above, or have any comments, derogatory or otherwise, I should be delighted to hear from them [at Cranley Lodge, Cranley Road, Guildford, Surrey].

Guildford, Surrey. W. R. SOWREY.

THE INDUSTRY

Major F. C. Atkinson

WE regret to learn, from Vickers-Armstrongs, Ltd., of the sudden death of Major F. C. Atkinson, O.B.E., at the age of 68. Felton Clayson Atkinson was, for 30 years, chief inspector at the company's aircraft division at Weybridge, a post from which he retired only two years ago. Throughout the great aeronautical progress of the 1920s and 1930s, Maj. Atkinson, in his position of chief inspector, kept abreast of the new techniques, and saw the wood and fabric biplanes replaced by metal construction and by the monoplane. During World War II, when Weybridge and many other centres were producing Wellingtons, Maj. Atkinson had to organize and control a much-expanded inspectorate, and (his colleagues recall) he was ever conscious of the responsibility he and his staff bore to the bomber crews of the R.A.F. After the war, more famous prototypes passed through his hands. When he retired, on March 31st, 1953, after a few months short of 30 years of service at Weybridge, both the Valiant and the Viscount had been granted super-priority.

Maj. Atkinson.

Born at Ashford in Kent, he served through the first World War with the Armoured Car Division of the R.N.A.S. and later with the R.A.F. Just after the end of the war he was appointed to the staff of the new R.A.F. College at Cranwell, but, in the early 1920s he went to Japan as a member of the Master of Sempill's mission to advise the Japanese Government on aviation matters. It was on his return that he joined Vickers as chief inspector. Maj. Atkinson leaves a widow, a son and a daughter.

Power Points

IN connection with the establishment of the Javelin production line at the main works of the Gloster Aircraft Co., Ltd., a comprehensive system has been adopted for bringing compressed air and electrical power to portable tools used at each jig or assembly position. It was desired to avoid the use of overhead lines and, of course, any cables trailing along the floors; furthermore, the area in which the works is situated is rather damp, so special care had to be taken in protection against moisture.

For these reasons an under-floor conduit system was adopted, incorporating some hundreds of plug-in boxes designed and manufactured by the General Electric Co., Ltd. Of heavy-gauge mild steel, hot-spelter-galvanized and with interiors coated with Corktex paint (a compound used by the Admiralty as an anti-condensation finish) the boxes have cast aluminium alloy lids stated to be capable of sustaining a weight of 30 tons. When the cables and/or air-lines have been plugged in, the lid is closed, the lines then passing through a small recess.

Keeping it Clean

NOW being used to an increasing extent by aircraft operators and the industry is the range of industrial vacuum cleaners made by New Welbeck, Ltd., 120 New Bedford Road, Luton, Beds. Users in the industry, it is stated, include English Electric, Fairey, de Havilland, Rolls-Royce and Folland; and these cleaners are also being used in the servicing of R.A.F. aircraft of the Queen's Flight, and in the U.S.A.F.

A characteristic of the equipment is portability, each machine being light and compact enough to be taken to any part of the work area, where it is used with a short length of hose. The dust-bag commonly used in domestic machines is dispensed with, the dirt going straight into the metal container and the air exhausting through a self-cleaning filter.

The New Welbeck range consists of three models, the Simplex, Duplex and Triplex, with one, two and three driving motors respectively; there is also a lightweight machine, the "Bak-Vak"; designed to be carried on the operator's back, it weighs 16½ lb complete. For all models there is a wide range of nozzles, brushes, etc., for use in various situations.

Awards to Folland Apprentices

THE company's first Spitfire Mitchell Scholarship winner was among the eleven apprentices who received awards when Folland Aircraft, Ltd., held their annual prize-giving at the Royal Pier, Southampton, on February 11th. The presentations were made by Mr. D. G. James, M.A., Vice-Chancellor of the University of Southampton.

Introducing Mr. James, and the company's new education officer, Mr. J. Keiser, Mr. W. E. W. Petter (managing director and chief engineer) said that the company now had so many apprentices that in some of the shops they were almost an inconvenience —"but," he hastened to explain, "we are in a state of expansion and soon we are going to need the services of all these boys." Follands prospects, he added, were such that the standard of skill reached by the apprentices would be of even greater concern to the company than in the past. To improve existing facilities, a training workshop was to be set up, in which boys would be taught the use of hand tools and certain machine tools before they entered the shops.

In his report on the work of the apprentices during the year, Mr. Keiser said that the company had more than 250 apprentices under training, more than half of whom were trade apprentices. In future, the annual intake would be between 40 and 50, roughly the number of applications he received each month.

Under an exchange scheme, said Mr. Keiser, two Folland apprentices had spent three month last year with a Hamburg firm of tool-makers, two of whose apprentices had spent three months with Follands at Hamble.

Prize-winners were T. W. Brown, G. Chisman, J. D. Davis, D. Gibson, L. Hunt, B. Knight, P. Lutman, N. S. A. Murphy, S. D. A. Redman, A. F. P. Trist and J. R. Young. J. D. Davis (the Mitchell Scholarship winner) was declared the outstanding apprentice of the year and received both the H. P. Folland Cup and a brief-case presented by Mr. W. E. W. Petter.

IN BRIEF

Consolidated profits of H. M. Hobson, Ltd., recently announced for the year ended September 30th, 1954, were £454,865 (previous year, £423,060). Deduction for depreciation and taxation left a net profit of £169,040 (£129,854).

* * *

All the Viscounts for Trans-Canada Air Lines are being fitted with Venner emergency lighting units. This type of fitting, which is A.R.B. approved, lights automatically at a deceleration of 1.25 g, and is easily released for use as a hand torch.

* * *

Fine machine engraving has now been added to the services offered by Braithwaite, Court and Co., Ltd., technical illustrators, of 23 Commercial Road, Woking, Surrey. Mr. A. Evans, formerly of Winston Electronics, Ltd., has joined them as sales director.

* * *

The instrument-testing and associated equipment produced by Rollason Aerocessories, Ltd., Croydon Airport, is the subject of a new loose-leaf catalogue. Special emphasis is placed on the range of R.A. sensitive control valves, for which final patent approval has recently been granted and which are already being widely used in the aircraft industry, principally for flow control in instrument testing, though other potential applications cover a much wider field. Apart from sensitive control of gases or liquids, characteristics of these valves include positive sealing, freedom from leaks, positive stops at extreme travel, and adaptable mountings.

* * *

Western Manufacturing (Reading), Ltd., report a net profit of £172,413 for the year ended October 31st, 1954.

* * *

Appointed to the board of Power Jets (Research and Development), Ltd., are Capt. (E) E. A. G. Whittle, R.N., and Mr. J. H. Pitchford, M.A., M.I.Mech.E., managing director of Ricardo and Co., Engineers (1927), Ltd. Capt. (E) E. J. H. Kirby, D.S.C., R.N., has resigned from the Board on change of Admiralty duties and Rear-Admiral W. G. Cowland, C.B., has resigned owing to pressure of other work.

* * *

Although formed comparatively recently—in 1951—the firm of Appleby and Ireland, Ltd., Kempshott, Basingstoke, Hants, has already become widely known in the aircraft and other industries for the production of precision instruments, mainly for research purposes. Instruments illustrated and described in a loose-leaf catalogue recently issued include absolute pressure gauges, sensitive and differential pressure gauges, vacuum and pressure/vacuum gauges, aneroid barometers and barographs. Special attention is drawn to the company's ability to design and manufacture instruments to customers' special requirements.

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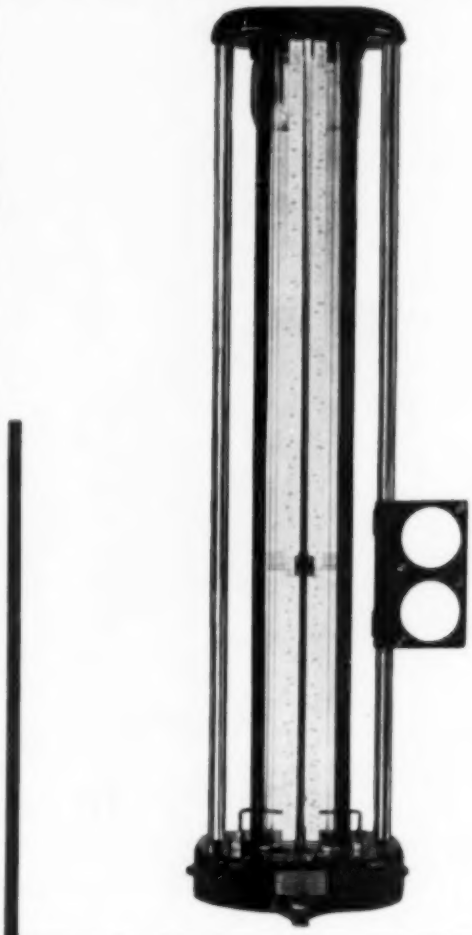

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TWO SUPERSONIC FIGHTERS

—*in the News: F-100 and F4D*

DEVELOPMENT problems, already acute in any modern military aircraft, become truly formidable in aircraft designed to achieve sustained supersonic speed while fully equipped as a line-of-battle fighter. The first machine in this category was North American's F-100 Super Sabre—the first of the "sonic centenarians" of the U.S.A.F. fighter lineage.

As briefly discussed last week, the F-100 ran into its first real trouble as late as last autumn, by which time the Los Angeles plant was filled with airframes in various stages of completion and many aircraft were ready for issue to U.S.A.F. squadrons. Three Super Sabres were destroyed in quick succession, and each accident seemed to be the result of some fault in the aircraft.

The most significant accident occurred on October 12th, 1954. On that day George Welch, North American's chief engineering test pilot, was booked to perform the most severe structural test then applied to the type; his flight-test card called for a supersonic dive with a symmetrical pull-up at the medium altitude of 23,700ft. Taking off in a heavily instrumented research F-100, Welch called up at 11 a.m. to report that he was ready to start to dive at his aiming point of Rosamond Dry Lake, Mojave Desert. What ensued was reported by a pair of B-47 pilots on their way back to Castle A.F.B. from practice bombing over the Salton Sea.

The Stratojet was at 25,000ft over Palmdale when its crew spotted the contrails of the F-100 at a height estimated at 45,000ft. As they watched, Welch rolled-off to the right and began his dive between three and a half and five miles ahead of the bomber. The F-100 passed their altitude diving at 70 to 80 deg, and moving so fast that they had to turn their heads rapidly to follow it. Then, without any previous sign of instability, it broke up in what appeared to be an explosion.

North American engineers flew to the scene and started an investigation with personnel from the U.S.A.F. Flight Safety Directorate at Norton A.F.B. A complete plot was made of the exact position of every piece of wreckage, and the parts were then taken back to the company's main plant at Inglewood. Here, the real investigation got under way. One line of the search was based upon the exposed film found in a camera which had been mounted in the fin of the F-100 to record the behaviour of the port slab-tailplane. Although the electric power to this camera had been cut during the break-up, the camera had taken a few more frames under its own momentum.

When the film was developed and projected, an erratic shadow was seen to race across the surface of the tailplane; it was cast by the fin and rudder, and indicated that the aircraft had experienced a violent and unusual type of manœuvre. By employing a model illuminated by a light placed exactly at the bearing and azimuth of the sun at the time of the accident, this manœuvre was reproduced fairly accurately.

Later, oscillograph records were recovered which gave actual control forces and positions; and these provided what the company's chief engineer, Raymond Rice, termed "the first and most reliable real clue as to the probable primary cause."

The records showed that the F-100 had suddenly taken a violent yaw to starboard—no quantitative data have been released, but the yaw was termed "considerable"—resulting in rapid loading beyond the design limits, and hence disintegration. The yaw resulted from the coupling of the principal moments of inertia; this largely took the form of a rapid transfer of energy from the roll axis to either the pitch or yaw axes, and back again. This behaviour had never before been met, and is only serious in aircraft with large, long fuselages and short-span wings. Secondary terms in the design equations, formerly ignored, now have to be calculated.

Uncontrolled gyrations of the type which proved fatal to the F-100 can be met by fast low-aspect-ratio aircraft with any type of wing-plan. They can be encountered at critical angles of attack or at critical load factors; in the case of the F-100, they were met at from 1 g to 3 g. Supersonic velocity was not, of itself, a contributing factor. Normally, any violent, or uncoordinated, rolling manœuvre results in pitch and yaw which is damped by the tail; in the F-100, however, the moments exceeded the capacity of the tail to restrain them, and it was at that point that the aircraft went violently out of control.

The unusual final assembly line at Torrance, with Douglas F4Ds ("Fastest Naval Aircraft," below) lying in a trough in the floor. The one-piece method of making the fuselage and wing is stated to ease production considerably.

Modifications were soon put in hand, and three modified production F-100As have since been intensively flown. In particular, violent rolling manœuvres have been done at all conditions of speed and loading, without trouble. The modifications include: one foot added to each wing-tip (span now 38ft) so producing and aft-shift of c.g.; 27 per cent more area to the vertical tail, thus returning it virtually to the form of the tail on the YF-100 prototype; and minor changes to improve control "feel." Earlier this month, the 100-plus F-100As now built were "ungrounded."

Fastest Naval Aircraft. The other level-sonic fighter in the news is the bat-like Douglas F4D Skyray. Powered, like the Super Sabre, by an afterburning Pratt and Whitney J57, the F4D is the fastest (and the fastest-climbing) aircraft in any Navy. The basic design of this carrier-based intercepter was settled in 1948. The requirement of catapulting (zero to 80 knots in the length of the accelerator) inevitably added weight; but, although the F4D has rather less range than day fighters, the weight-limit of 20,000 lb (two-thirds that of contemporary fighters) is regarded as remarkable.

Robert Rahn, chief test pilot of the Douglas El Segundo factory, established the present world 100-km circuit record in an F4D. Another record—the world speed record—was set in the same aircraft by Jim Verdin, who also became an El Segundo pilot and was tragically killed in a prototype A4D Skyhawk on January 13th. Verdin has described his first solo introduction to the Skyray as follows: "Like most pilots I had to find out something for myself. Through my own error I put the airplane into a spin. I spun all right—six times. I got out of that one, and I went on to fly the airplane with a lot of success that day. In spite of that introduction, I've grown to have more confidence in the F4D's performance than in any other airplane."

Not only has the F4D ample flight performance, but it is also proving to be something much more valuable—a good fighting aircraft. In addition to four of the new 20mm U.S.N. cannon, the Skyray can carry six packages each housing seven 2.75in rockets, four packages of 19 rockets, two 300-U.S. gal tanks or two 2,000 lb bombs, under its wing racks. The aircraft at present in production at Torrance are of the F4D-2N type, fitted with full all-weather radar "locked-on" to the autopilot.

FORTHCOMING EVENTS

Feb. 26. Northern Heights Model Flying Club: Annual dinner and dance.

Feb. 26. S.L.A.E. (South-eastern Area): "Fire Protection and Prevention Equipment in Aircraft," by A. Cdre. Sir Vernon Brown, C.B., O.B.E., M.A., F.R.Ae.S. Hon., M.S.L.A.E.

Mar. 1. R.Ae.S. Section lecture: "The Scientific Approach and Research in Aircraft Production," by Prof. J. V. Connolly, B.Eng., F.R.Ae.S.

Mar. 3. British Institution of Radio Engineers (North-western section): "Computing Circuits in Flight Simulators," by A. E. Cutler, B.Sc., Ph.D.

Mar. 5. British Interplanetary Society: "Radio Exploration of Space," by R. C. Jennison, B.Sc.

Mar. 5. British Interplanetary Society (Midlands branch): "The Path to Space Travel," by K. W. Gatland.

Mar. 5. The Cranfield Society: Annual dinner and annual general meeting.

Mar. 9. R.Ae.S. Graduates and Students Section: Annual general meeting and film show ("The Society Overseas," by A. M. Ballantyne, T.D., Ph.D., A.F.R.Ae.S.).

Sept. 5-11. S.B.A.C. Show, Farnborough.

R.Ae.S. Branch Fixtures (to March 15th)

Mar. 1, Boscombe Down, "Developments in Gliding," by A. H. Yates. *Mar. 2, Brough,* "Pilots' Limitations in Aircraft Design," by W/C. H. P. Ruffell Smith; *Luton,* "Aerial Photography." *Mar. 3, Isle of Wight,* "Aircraft Engineering in the Arctic," by Maj. James H. Webb, U.S.A.F. *Mar. 8, Bristol,* Second Barnwell Memorial Lecture, by Walter Tye. *Mar. 15, Manchester,* "Helicopters," by C. S. Hislop; *Belfast,* "Aerial Photography," by Charles Brown.

Civil Aviation

THE COMET'S FUTURE

Government Statement: B.O.A.C. Order Increased

ON February 16th, four days after the publication of Lord Cohen's report into the Elba and Naples accidents, an official statement of Government policy on the future of the Comet was made in the House of Commons by Mr. J. Boyd-Carpenter, Minister of Transport and Civil Aviation. After paying tribute to the "clear and masterly" report, and stating that the Government had no hesitation in accepting the recommendations of the Court, the Minister said:—

"The knowledge gained in this investigation will enable the Comet to be strengthened and made safe for future operation. As the House will be aware, B.O.A.C. have on order 12 Comet 2s and five Comet 3s. They are now discussing with de Havillands the future composition of their new Comet fleet and, indeed, contemplate increasing their order to 20 aircraft.

"In addition, a number of Comet 2s in a modified version are being ordered for delivery to the R.A.F. for Transport Command as early as the work involved allows. Special pressure-tank tests will be arranged and the aircraft will be required to obtain a full passenger Certificate of Airworthiness before they can go into service.

"Comet 1 aircraft cannot be made suitable for further airline use without extensive and costly modifications. Certain of the existing aircraft, which can be usefully employed to further research and development work for which the Ministry of Supply is responsible will be required by that Ministry. The aircraft will, in particular, be used to assist the programme of further testing and research which was recommended by Lord Cohen in his report."

A second statement on the Comet was issued on February 16th by B.O.A.C.; the text was as follows:—

"British Overseas Airways Corporation announces that after studying the Cohen Report on the Comet 1 it has decided immediately to instruct the de Havilland Aircraft Company to proceed with the building of a fleet of New Comets. The orders for Comets have never been cancelled. It has been decided that the Comet 1 aeroplanes that originally formed B.O.A.C.'s fleet will not be used again on public passenger service.

"The technical findings of the Cohen Report, made possible by the remarkable salvage work of the Royal Navy and the thorough research at the Royal Aircraft Establishment at Farnborough, satisfy the Corporation that the cause of the failures of the Comet 1 airframes has been found and can be eliminated by strengthening the fuselage structure. This the de Havilland Company will do in the design and construction of the New Comets. The New Comet airframe design will be subject to thorough prototype tests. These will include a full series of repeated pressure tests such as were used by the Royal Aircraft Establishment at Farnborough in the testing of the Comet 1 airframes. Thereafter the Comets will be flown by the makers and B.O.A.C. for many thousands of hours on service tests and route familiarization before they are put into passenger service."

Sir Miles Thomas, chairman of B.O.A.C., said in Trinidad, where he has been making a short official visit, that the Corporation would "make haste slowly" and satisfy itself fully before offering the "New Comets" for passenger service, "eagerly though our pilots and flying staff look forward to the resumption of our jet schedules." Sir Miles added that B.O.A.C. were "in close consultation with de Havillands as to the precise constitution and date of delivery of this increased fleet.

"The New Comets will be heavier," Sir Miles continued, "being more strongly built than the Comet 1s, but the extra power given by the Rolls-Royce Avon engines with which they will be fitted will give them a performance and range that make them commercially pre-eminent in their eras. No precise date can yet be given for their re-introduction into service. This depends on the manufacturing programme."

Expressing pleasure at the news given in the Commons statement, the de Havilland Aircraft Co. stated: "We have a number of contracts to supply Comet 2s and 3s to Commonwealth and foreign countries and we must now discuss with operators the new delivery dates and other matters which result from the changes called for by the Inquiry Report."

The phrasing of the B.O.A.C. statement casts doubts on the assumption—though it was a valid one until very recently—that both Series 2 and Series 3 Comets, suitably modified, would be developed and produced as originally planned, though for delivery at somewhat later dates. It is now thought probable that the 20 "New Comets" for B.O.A.C. will be of one basic type embodying features of both versions, the characteristics of the larger Series 3 being predominant. It does not necessarily follow that de Havillands will no longer offer the Comet in two forms, with capacity suited to slightly differing stage-lengths and traffic densities. However, the policy of B.O.A.C., as the first and, so far, the largest customer, is certain to influence other operators.

The D.H./B.O.A.C. lead in building and operating jet transports has by no means been lost, though it has been lessened. The attraction of standardization is that, at this critical stage, it would reduce the time required to build, test and prove Comets for service with B.O.A.C. and other airlines. It may be that, assuming B.O.A.C.'s Comets are to be all of a kind, the payload-range characteristics of the one type would meet the needs of most potential Comet operators. Presumably the answer to this question will emerge from talks between the makers and operators during the near future.

Since the suspension of Comet services ten months ago there has been no break in discussions between de Havillands and the main overseas airlines interested in the future type of Comet; naturally, however, no more than tentative conclusions could be reached on either side, in view of uncertainty as to the outcome of the investigations and Inquiry. These discussions can now be continued on a much less hypothetical basis.

For their part, the makers are certain that those companies who order Comets now, as well as those who reaffirm orders placed before the accidents, will derive assurance from the past history of the Series 1—paradoxical as this may seem. They point out that, apart from its 30,000 hours of airline service, enabling every feature of the aircraft to be proved (and, where necessary, modified) under operational conditions, the Comet has been subjected to more extensive scrutiny than any other transport aircraft. And the Series 1's successors, embodying all the knowledge which emerged from the investigation, will themselves undergo full revised ground and flight trials before entering service.

The remaining Comet 1s are, as mentioned in Mr. Boyd-Carpenter's statement, to be used for research and development flying by the Ministry of Supply. They are particularly suitable for the purpose envisaged, having the largest pressure cabins available for test work at representative speeds and heights. It is not proposed to rebuild the pressure cabins of the Comet 2s ordered for Transport Command; however, critical cut-out areas will be reinforced and the cabin, thus modified, will be tank-tested.

A restriction on the number of pressurized hours flown may be a condition for the award of a C. of A. for this version of the Comet. It is hoped that first deliveries will be made to Transport Command this year.

L.A.P. TERMINAL TRANSFER

DETAILS have been given by M.T.C.A. of the proposed division of services between the existing terminal buildings at London Airport and the new central-area passenger terminal, which will come into use on April 17th next. The following airlines, whose movements are of the short-haul type, will use "London Airport Central": Aer Lingus, Air France, Alitalia, B.E.A., Deutsche Lufthansa, Finnair, Iberia, Iceland Airways, Sabena, S.A.S. and Swissair.

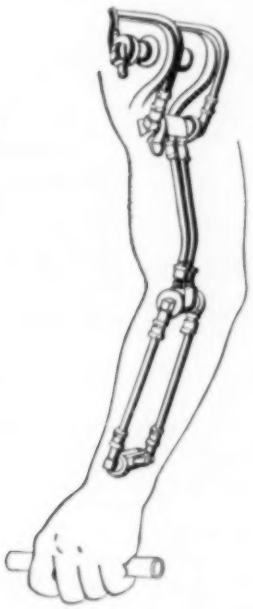
Road traffic for L.A.P. Central will enter and leave *via* the western ramp which turns off the Bath Road some 700 yards west of the present main entrance and leads into the tunnel feeding the area.

The following airlines, most of which operate long-haul services to and from London, will continue to use the existing buildings at L.A.P. North: Air India International, Airwork, Argentine Airlines, B.O.A.C., Central African Airways, El Al Israel Airlines, Hunting-Clan Air Transport, K.L.M., National Greek Airlines, Pakistan International Airlines, Panair do Brasil, Pan American World Airways, Qantas Empire Airways, South African Airways, T.A.P. (Portuguese Airways), Trans-Canada Air Lines and Trans World Airlines.

For traffic from London, access to L.A.P. North will be *via* the eastern gate, about 500 yards short of the present main entrance, and then *via* the internal airport road running parallel to the Bath Road. Traffic from the west may continue to use the main entrance, which will also be the exit for all traffic leaving L.A.P. North. The Ministry statement adds that all traffic routes will be clearly signposted.

This division of short-haul and long-haul passenger terminal facilities is not, of course, intended to be permanent. The central area will handle all the airport's traffic when the whole group of buildings has been completed.

Problems of a Piping Designer



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This drawing of the Fokker F.27 Friendship—described as a Dutch-British venture on account of its English Dart turboprops, their airscrews, the landing gear, wheels, instruments, seats and Redux-bonding—provides an impression of the aircraft in its latest form and, for the first time, in K.L.M. colours. The prototype is well advanced and is expected to fly early in the summer.

CIVIL AVIATION . . .

BE.25 BRITANNIAS FOR QANTAS

AUSTRALIA'S international airline, Qantas Empire Airways, is discussing with the Bristol Aeroplane Co. the possibility of an order for a number of later-model Britannias powered by constant-power BE.25 turboprops. This was announced in London last Monday by the airline's general manager, Mr. C. O. Turner, who said that the aircraft would be required for delivery in 1959-60. Mr. Turner did not specify the reasons for postponing the introduction of Britannias, but the fact that Qantas now have a brand-new fleet of nine Super Constellations, with a tenth due for early delivery, suggests that the company is well placed to await the debut of the improved-type Britannia.

Earlier, Qantas had given Bristols a letter of intent for six Mk 250 Britannias, to be powered, like B.O.A.C.'s Mk 300s, by Proteus 755 turboprops, but specially designed to carry a mixed load of freight and passengers in the main cabin. Mr. Turner said that the ability to carry mixed loads would also be a feature of the BE.25-powered machines now under negotiation. He added that by 1956 the airline's Super Constellations will be modified to carry up to 16,000 lb of freight in addition to 57 passengers on the London-Sydney route. Apart from cabin modifications, the aircraft will require wing-root strengthening to permit an increased zero-fuel weight.

As a first step towards increasing freight capacity on the Kangaroo route, Qantas will shortly introduce direct all-freight service between London and Sydney; a DC-4 freighter has been bought from the United States for this purpose, increasing the airline's DC-4 fleet to six aircraft. Previously, the only all-freight route to Sydney has been by B.O.A.C. York to Singapore, and thence by Qantas DC-4. Including the cargo space offered on passenger aircraft, the two airlines have been offering a total monthly freight capacity in each direction between London and Sydney of 80 tons; this figure is now to be increased by 50 per cent.

SUPER SUPER CONSTELLATION

THOUGH its existence has not yet been officially announced, the Lockheed L.1549 can be regarded as a formidable combatant in the growing sales battle for the custom of the long-range international airlines. Towards the end of 1954 it became generally known that Lockheeds were sounding operators' reactions to the L.1449, a lengthened version of the L.1049 Super Constellation with a new wing and four 6,000 h.p. T-34 turboprops (first details were in *Flight* for December 17th, 1954, and January 14th last).

This sales reconnaissance produced a number of design changes, resulting in the new designation L.1549. It is believed that T.W.A. have signed, or are on the point of signing, an initial order for 25 L.1549s, with first deliveries in 1957.

There is a good case for expecting T.W.A. to place such an order. First, the company must prepare for competition from Pan American, S.A.S. and Swissair, who have ordered DC-7Cs for non-stop transatlantic service in 1956-57; secondly, T.W.A., now operating the largest Constellation and Super Constellation fleet in the world, would be reluctant to change over to Douglas equipment unless they stood to gain some significant lead.

It might well be asked why Lockheeds have not formally announced their plans for the 1549. The best explanation is that over-emphasis of projected designs can prejudice sales of current models. This is reflected in the sales techniques of both Douglas and Lockheed: publicity campaigns are centred on the DC-6B, DC-7 and L.1049, while tomorrow's aircraft are discussed behind the scenes with executives of the major airlines. The DC-7C was not "unveiled" by Douglas until last September, by which time the P.A.A. contract had already been clinched. Similarly, it is expected that the L.1549 will not be formally revealed until T.W.A. choose to announce the signing of a contract; there may even be a clause in the contract reserving the initial publicity rights to the airline. Meanwhile, it is possible to piece together, from various sources, the essential features of the aircraft.

In relation to the L.1049, the major design innovation is the adoption of a high-aspect-ratio, tapered wing of increased span (150ft, compared with 113.7ft) and greater area (1,850 sq ft, compared with 1,650 sq ft). The 1549 has already been dubbed the "thin-wing" Super Constellation; thickness-chord ratio has, in fact, been reduced by nearly 17 per cent.

The 1549 will be powered by four 6,000 h.p. Pratt and Whitney T-34 turboprops, fed by a four-tank fuel system containing 10,200 U.S. gallons. The power-units are housed in nacelles of low frontal area, the inboard nacelles being bulged to accommodate the main undercarriage (which—surprisingly, in view of the size of the aircraft—is not of bogie-wheel type).

The fuselage of the 1549 is expected to accommodate about 90 tourist-class passengers, or 60-75 in a first-class layout; it will be about 10ft longer than the L.1049, which measures 113ft 7in from nose to tail. In relation to the proposed all-up weight of the 1549 (18,500 lb), the capacity payload of about 18,000 lb is decidedly low; the aircraft is intended, however, to be capable of carrying this load over distances of nearly 4,500 miles. Though extremely valuable for specialized long-haul work, it would be inflexible and uneconomic over the routes flown by a majority of international operators. Cruising speed of the L.1549 is expected to be 410-420 m.p.h.

NEW AERAD FLIGHT GUIDE

A RECENT change in the format of the *Aerad Flight Guide* has been explained by International Aeradio, Ltd., who originally introduced the *Guide* in 1947. In its revised form, the new *Guide* is designed to provide quicker references to radio call signs, frequencies, control procedures and airways systems. It is in two sections, the first (the Radio Handbook) containing such information as radio details, diagrammatic charts showing airways, safety altitudes, tracks and distances, danger areas and meteorological information; it is published as seven separate spiral-wire bound and expendable volumes which are re-issued periodically. Interim amendments are issued weekly.

The Radio Handbook covers the following areas: Europe and Middle East; Africa; Asia; Far East and Pacific; Australasia; North Atlantic and Seaboard of North America; and South Atlantic and South America.

The second section, the Pilot's Handbook, contains charts for

Lockheeds are reported to be grooming a contender for the transatlantic non-stop stakes in the form of the L.1549, a stretched, turboprop version of the Super Constellation. This "Flight" artist's impression shows it in the colours of T.W.A., who are said to be considering an order for 25.

CIVIL AVIATION . .

"Brandnew"—to quote the German news-agency caption—"rolled on Sunday this pretty Convair over the runway of Hamburg-Fuhlsbüttel . . . the first machine of the German Lufthansa, which was now presented with all regulation signs of nationality, ready for starting."

instrument approach and landing procedures, holding procedures, inbound and outbound routings for terminal airports, and aerodrome lists. Divided into countries, this handbook is in loose-leaf form and is brought up to date weekly by the issue of new sheets.

These two sections provide all essential information in such a form that it eliminates the need for reference to different parts of the manual to cover one phase of a flying operation. Moreover, users of the Radio Handbook are freed from the necessity of hand-amending or inserting new pages to meet constantly changing information. Division into separate sections also means that pilot and radio operator have their own sections, and, that being less bulky, the volumes are more easily handled in the confined space of the aircraft cockpit.

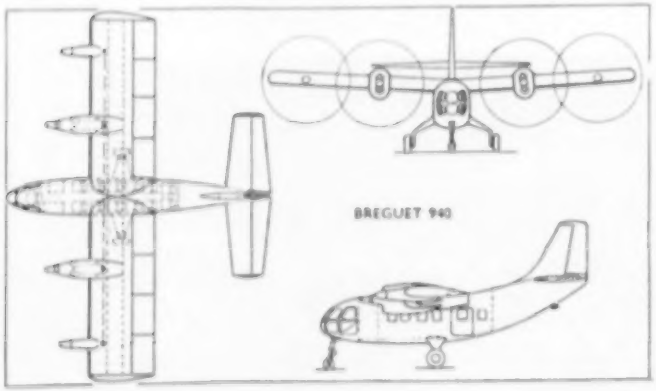
BRÉGUET SHORT-TAKE-OFF PROJECT

SOME further information is now available concerning the Bréguet 940. This aircraft might be termed a helicopter substitute, since it is designed to take off in about 43 yd with a 12-passenger load. Some preliminary details appeared in *Flight* on December 17th.

The 940, as the general arrangement drawing below shows, has a fixed high wing with large double flaps. The powerplant consists of four Turboméca Turmo IIs of 400 h.p. each, mounted in pairs in two nacelles. There are four Ratier airscrews, each of 13ft diameter with electrically variable pitch, designed to give very high thrust at take-off and average thrust for cruising. All four airscrews are linked by a common drive-shaft running within the wing, and during the critical take-off phase the outer airscrews can be differentially controlled by the pilot to give directional stability. The airscrew slipstream is, of course, designed to provide a high airflow over the wing, whose whole span is within the combined airscrew disc area. The common drive-shaft is also a necessary safety-factor since engine failure at take-off must not be allowed to stop one of the airscrews. Directional control at very low speed is further assisted by diversion of the efflux of a small turbojet mounted close to the tail.

The Bréguet 940 is to have a span of 52ft (chord 18ft), a wing area of 500 sq ft and length 38ft. Empty weight is in the region of 5,200 lb. This new Bréguet project is claimed to overcome one of the helicopter's disadvantages—its extreme vulnerability in case of engine failure at between 30ft and 200ft altitude during vertical take-off or landing. To avoid this, helicopters now in operation normally make an inclined take-off, and this manœuvre could be equalled by the Bréguet. The latter, moreover, would have better cruising speed and range than either the helicopter or convertiplane and would have to undergo none of the latter's mid-air changes of configuration.

The Bréguet 940 affords an interesting comparison with that company's V.T.O. project which relied on rotors recessed in the wing. It was described briefly in an article on vertical take-off which appeared in *Flight* on September 10th, last year.



SECOND VISCOUNT FOR HONG KONG

THE total number of Viscounts now delivered or on order increases to 179 with the announcement that Hong Kong Airways have taken up their option to buy a second Viscount 700D. The initial order for one such aircraft was announced last October. Both aircraft will be fitted with wing-mounted "slipper" tanks to give increased range. An indication of the current price of the Viscount is given by Vickers-Armstrongs' statement that the total value of the order, including spares, is approximately £650,000.

LUFTHANSA FLEET PLANS

BY the end of 1956 Lufthansa expect to have a fleet of 15 aircraft, according to Herr Weigelt, chairman of the new German airline. It would consist of three DC-3s, four Convair 340s and eight Super Constellations. The Convairs have already been delivered to Lufthansa's base at Hamburg and they are due to be introduced to service on April 1st; the DC-3s are to be used as reserve aircraft and for the carriage of freight and spares. Delivery of the first four Super Constellations will begin shortly, and these aircraft will be used on the North Atlantic route. Delivery of the second batch of four is not due until 1956, when Lufthansa plan to extend their long-range services to South America and the Far East.

BREVITIES

THE M.T.C.A. announce the formation of a new directorate, the Civil Aviation Overseas Navigational Services Directorate, which will deal with technical and operational problems relating to aerodromes, control, navigation and telecommunications on overseas routes. Mr. E. L. T. Barton, O.B.E., has been appointed director.

* * *

Mr. John Crewdson.

As reported recently in *Flight*, ex-B.E.A. pilot John Crewdson is acquiring an Italian-built Bell 47-G for film publicity and charter work; it will be operated by Rotor-films (London), Ltd., with Mr. Crewdson and Mr. T. M. Clutterbuck as co-directors. Operations are scheduled to begin next month.

* * *

B.E.A. have taken delivery of one of the two D.H. Herons ordered recently for service in Scotland. The aircraft, G-ANXB, *Sir James Young Simpson*, was flown from Chester to Renfrew on February 12th.

* * *

From April 7th, Central African Airways will increase the frequency of their Zambezi Colonial Coach service from once to twice weekly. Operated by 27-seat Vikings, the services operate between London and Nairobi, Blantyre, Ndola, Lusaka and Salisbury.

* * *

Impressive amounts of rotary-wing experience are being built up by pilots of Sabena. The Belgian airline's chief pilot, Capt. Trémérie, has now logged 4,100 helicopter flying hours. This exceeds slightly the time logged on mail work in the Chicago area—4,000 hours—by Helicopter Air Service pilot H. W. Symes. This pilot, however, is believed to hold the record for the total number of helicopter hours flown, having already 1,500 hr to his credit when he joined H.A.S. in February, 1950.

High over East Anglia a sextet of Hawker Hunter F.2 intercepters (Armstrong Siddeley Sapphire turbojets) of Wattisham-based No. 257 Squadron are seen (from a Meteor N.F.14 night fighter of No. 152 Squadron) between two layers of cloud.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

Bomber Contests

THE annual visual and blind bombing contests for Canberras and Lincolns of Bomber Command and 2nd T.A.F. will take place on the nights of March 28th to April 7th inclusive. Bombing will be carried out at heights ranging from 14,000ft to over 30,000ft.

Five trophies will be awarded. The Laurence Minôt trophy will be awarded to the Lincoln squadron achieving the most accurate blind bombing and the Sir Geoffrey Salmond trophy to the individual Lincoln crew with best blind-bombing score. The Armament Officers' trophy will go to the Canberra squadron gaining the best score in both visual and blind bombing, and the Lord Camrose trophy to the best Canberra visual-bombing squadron. The fifth award, known as the Gee H. trophy, will go to the individual Canberra crew achieving the best blind-bombing figures.

Canberra squadrons will each enter six crews and Lincoln squadrons four crews. During each round, one crew from each squadron will bomb three targets in the course of a cross-country flight. Details of targets, routes and timing will be given to the squadrons four days before the start of the competition.

The Sovereign's Standard recently presented to No. 45 Squadron in Singapore. It is held by F/O. J. H. S. Greenwood, who acted as Bearer during the presentation ceremony. The badge depicts a flying camel, a reminder that No. 45 was once equipped with Sopwith Camels, which it received in July 1917.

R.A.F. Signals Flight

THE Hastings aircraft *Iris*—used by the R.A.F. Inspector of Radio Services for periodical inspection, advisory and liaison visits to the R.A.F. and Commonwealth Air Forces signals units throughout the world—left Benson, Oxon, on February 12th on a 27,500-mile flight to New Zealand and back. This is the longest flight ever undertaken by *Iris* or any of its predecessors, and for the first time includes a visit to New Zealand, at the invitation of the Royal New Zealand Air Force.

Fourteen countries will be visited, the Hastings flying *via* Malta, Cyprus, Aden, Ceylon, Malaya, Hong Kong, Singapore, Indonesia and Australia and visiting Habbaniya on the return journey.

Commanding the expedition is G/C. C. C. Morton, C.B.E., Inspector of Radio Services, and with him are W/C. A. R. Glading, S/L. J. S. Knox, D.F.C., A.F.C., and F/L. W. H. E. Austin, all of whom are members of the Inspectorate. The Hastings crew of seven is commanded by F/L. H. H. Roffey, captain of aircraft.

R.A.F. Appointments

AS from February 15th, G/C. D. G. Lewis, D.F.C., took over command of Southern Sector, Fighter Command, and G/C. L. P. Moore, C.B.E., became A.O.C. No. 43 (Maintenance) Group; both have the acting rank of air commodore.

G/C. Lewis served most of the war period in the Middle East and won his D.F.C. while commanding No. 84 Squadron.

G/C. Moore, who until lately was Command Signals Officer, F.E.A.F., joined the R.A.F. as a boy entrant in 1922 and in 1925 was awarded a cadetship at Cranwell.

The R.C.A.F. in 1954

THE steadily expanding R.C.A.F. is shown by a recent official summary to have had a busy and successful 1954. Its manpower strength rose to 48,000, several new types of aircraft went into service and parts were played in many of the major exercises that took place on both sides of the Atlantic.

During the year, Continent-based Sabres of the 1st Air Division acted as attackers in Exercise "Dividend," and the North Luffenham Squadrons helped the defenders, while units in Canada were involved in the joint U.S.-Canadian air-defence exercise "Check Point." Maritime Air Command joined NATO's CANLANT area exercise "New Broom II" and transport, reconnaissance and evacuation units of Tactical Air Command provided the aerial co.nponent for an Army-R.C.A.F. mobile striking force exercise in the Sept Isles and Churchill areas.

No. 426 (Thunderbird) Squadron's North Stars wound up their trans-Pacific airlift after 600 round trips during which they carried 13,000 passengers and over seven million pounds of freight without losing a single life or cargo. C-119Fs of Nos. 435 and 436 Squadrons also delivered 700,000 lb of supplies to Arctic weather-stations and aircraft from No. 405 MR Squadron flew ice patrols for Arctic re-supply ships. Finally, the search and rescue organization, including helicopters and para-rescue teams, combined in a large exercise with its U.S.A.F. counterpart.

On the equipment side, progress in 1954 was encouraging. The CF-100 Mk 4 began to reach the squadrons, and large

SERVICE AVIATION . . .

numbers of Orenda-powered, Canadair-built Sabre 5s reached Europe, permitting the delivery of 164 of the older Canadair Sabres and spare J-47 engines to Greece and Turkey. Plans were made to buy a number of Lockheed P2V-7 Neptunes, and Canadair began work on the marine-reconnaissance version of the Britannia. The R.C.A.F. also decided, in contrast to many air forces, that the first 20 to 25 hours of pilot training should be on Chipmunks before conversion to Harvards.

Delivery was taken of ten Sikorsky S-55 and six Piasecki H-21A helicopters.

After many years of faithful service from the type, three of the four last Ansons in service were put up for sale, while the fourth was stored at Chater, Manitoba, with other famous wartime aircraft.

The main Canadian early warning and control radar network, "Pinetree Chain" was completed in 1954 and the more northerly "Mid-Canada Line" was begun. Plans were also made for a new joint U.S.-Canadian Distant Early Warning Line in the far north.

In the training field, 700 students from nine NATO countries received their wings last year, bringing the total thus trained since 1950 to about 3,200. The Radio Officers' and Air Navigation Schools were also amalgamated at Winnipeg and the initial training courses largely combined. There was considerable scope for pre-service cadets, and one of the schemes resulted in 2,250 of them receiving training in aeronautical trades with both regular and Auxiliary units. The Auxiliary fighter squadrons, which at present have Mustangs and Vampires, began to receive T-33 Silver Stars in preparation for conversion to CF-100 night and all-weather fighters.

Finally, as reported in *Flight* on January 21st, No. 1 Fighter Wing began its move to join the other wings of the 1st Air Division on the Continent, leaving the Air Materiel base at Langar, Nottinghamshire, as the only R.C.A.F. station in the United Kingdom.

All this activity confirms that the R.C.A.F., though still comparatively small in numbers, is an important component of the air forces of the western world.

Some recent Service visitors to the Bristol factory at Filton were A. Cdre. G. J. C. Paul, D.F.C. (right), Commandant of the C.F.S., and G/C. O. I. Gilson, A.F.C., who commands the helicopter unit at South Cerney. They are with Mr. Roger White-Smith of the Bristol sales department.

The Boyd Trophy

CONSIDERED the most important annual award in the Fleet Air Arm, the Boyd Trophy has for 1954 been won by the Naval Test Squadron at the Aeroplane and Experimental Establishment, Boscombe Down. The squadron is commanded by Cdr. S. G. Orr, D.S.C. (Two Bars), A.F.C., R.N., who, as a sub-lieutenant, served under Admiral Sir Denis Boyd in H.M.S. *Illustrious*.

The announcement of the award by Vice-Admiral Sir John Eccles, Flag Officer Air (Home), says, in part: "The squadron has made a direct and forceful contribution to improving the breed of Naval aircraft during the past ten years of its existence as an entirely Naval unit. Its enthusiastic efforts with new and undeveloped types have had strong and beneficial influence on Fleet Air Arm quality in the air."

Ski Championship

AT Ehrwald, Austria, on February 20th, F/O. N. J. Galpin won the R.A.F. ski championship. F/L. Z. W. Kaye was second and F/L. A. H. Davis third.

Reunion

THE annual reunion dinner of No. 194 Squadron is arranged for March 5th at the Eccleston Hotel, London, S.W.1. Particulars from Mr. D. O. Williams, 63, Burnt Ash Hill, Lee, London, S.E.12.

R.A.F.'s 6-3 WIN at TWICKENHAM

AN interesting though slightly frustrating match between the R.A.F. and the Royal Navy opened the Inter-Services Tournament at Twickenham on February 12th. The Air Force won by 6 points to 3 (a try and a penalty goal to a penalty goal). Forecasts had suggested the possibility of a larger margin, for the R.A.F. had more "named" players, and a strong Rugby League element, but the Navy outsides marked well and tackled hard, preventing the R.A.F. line from achieving anything spectacular. As is usual in these Services matches, tackling was good all round.

Both outside lines played very unselfishly; at times, in fact, they pressed the team spirit to an extreme of passing which neutralized the real object of going all out for the line. The R.A.F. wings, Heaton and Griffiths, both lost chances through being too eager and lying too far up, so that they over-ran their centres. Some wild passes also spoiled several good movements, including one in which Howard had very neatly cut through the Navy line.

The most pleasing man on the field was Tregidon, the R.A.F.'s stocky little Welsh stand-off, who showed great promise in all aspects of the game. He received some nice long passes from R. I. Shuttleworth (brother of D. W. Shuttleworth) at scrum, and gathered the looser ones very well.

The Navy outsides were fast and bustling individually, but did not seem to be able to pull off many successful movements. The icy wind no doubt made handling and passing difficult for all. Carne was noticeable as a very determined runner.

Among the forwards, Yarranton was usually prominent and Bleasdale, the R.A.F. captain, held his pack well together. In the first half, the Navy appeared to get rather less of the ball, but after half-time they at least evened the shares. Mainwaring played his part in this direction, and it was he who, after a mis-fire on one penalty, kicked a second to produce the Navy's only score.

The R.A.F.'s penalty was kicked by Tregidon very early in the game, while the try was the work of Collard, who picked up and dived over from a scrum on the Navy line. Just previously, a good movement which seemed to be leading to a certain try was muddled on the line.

On March 5th the Royal Navy meet the Army, and the final match, between the Army and the R.A.F., will be played on March 26th. M.A.S.

The Royal Air Force rugby fifteen who beat the Royal Navy at Twickenham.

THE TEAMS

Royal Navy: Sub-Lt. G. J. Claydon; Sub-Lt. R. F. Carne; 2nd-Lt. S. R. Bemrose, R.M.; Sub-Lt. M. C. Rusling; Surg-Lt. A. S. Bater; E.R.A. R. McMenemy; Lt(E) H. Redrobe; 2nd-Lt. J. J. Rainforth, R.M.; Instr-Lt. G. P. Thomas; Stoker R. G. Waldron; A.A.4 I. J. Jenkins; Shipwright Artificer W. L. Copley; Lt(E) J. M. Dook; Lt. N. R. Moir (captain); 2nd-Lt. H. T. Mainwaring, R.M.

Royal Air Force: F/L. W. J. C. Patterson; F/O. J. D. Heaton; A/C. B. Howard; M. Sullivan; F/O. B. M. Griffiths; A/C. G. Tregidon; P/O. R. I. Shuttleworth; A/C. J. Wicks; F/L. N. M. Munnoch; F/O. G. Thorburn; F/L. P. G. Yarranton; L. A/C. J. Sewell; F/O. P. S. Collingridge; F/O. T. Bleasdale (captain); F/O. J. Collard.

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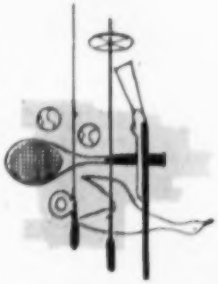

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PUBLIC ANNOUNCEMENTS

AIR TRANSPORT ADVISORY COUNCIL

THE Air Transport Advisory Council give notice that they have received the undermentioned applications to operate Scheduled Air Services:—

APPLICATION No. 339/2 from British Overseas Airways Corporation of Airways House, Great West Road, Brentford, Middx., for permission to include a traffic stop at Baghdad from June, 1955, on their Normal Scheduled Service on the route London-Frankfurt or Zurich-Rome-Nicosia or Beirut-Cairo-Abadan and/or Karachi, recently approved by the Minister of Transport and Civil Aviation for operation during the period ending October 31st, 1961.

FROM Airlines (Jersey), Ltd., of 4 The Parade, Jersey, Channel Islands:—

APPLICATION No. 40/3 for an increase in frequency on Saturdays during the high summer season on the sector of the Normal Scheduled Service which they operate between Gatwick and the Channel Islands from a maximum of 12 services to a maximum of 18 services.

APPLICATION No. 41/4 for an increase in frequency on the sector of the Normal Scheduled Service which they operate between Bournemouth and the Channel Islands, on which they are at present approved to operate terminating services at a frequency of two services daily on Fridays, Saturdays and Sundays during the high summer season.

APPLICATION No. 41/5 for permission to include Nantes as a terminal or transit traffic stop on the Normal Scheduled Service which they are approved to operate between the Channel Islands and Dinard, Rennes and/or La Baule, during the period ending 31st March, 1963.

APPLICATION No. 293/1 from Silver City Airways, Ltd., of 1 Great Cumberland Place, London, W.1, for amendments to the terms of the Minister's approval of the All-Freight Service which they are at present conditionally approved to operate for the period ending 30th November, 1959, between London (Blackbushe), Ferryfield and Southampton on the one hand and any or all of the following points on the other hand:—

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IT is a condition of approval of this service that on every flight calls must be made at not less than three points abroad before returning to the United Kingdom and that no flights in either direction without intermediate stops at either of the traffic points may be made between the U.K. and Brussels, Amsterdam, Hanover, Hamburg, Copenhagen, Frankfurt and Basle. In the present application, Silver City Airways, Ltd., ask for:—

(a) The inclusion of Antwerp as a traffic stop.
(b) Permission to operate direct flights from Southampton and Ferryfield to any of the Continental traffic points.
(c) Removal of the requirement that at least three traffic stops must be made on the Continent on every flight.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3, Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [3347

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The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order 1952.

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HANDLEY PAGE, LTD., require senior and junior technicians with degree or equivalent for work on aircraft flutter problems. Posts are progressive and salaries offered are commensurate with experience and qualifications.

WRITE (state age and full details of such) to: Staff Officer, Handley Page, Ltd., Cricklewood, London, N.W.2. [3331

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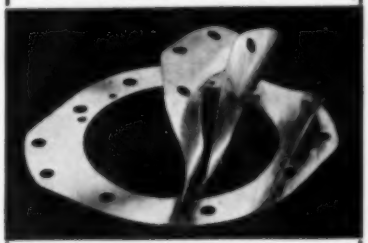

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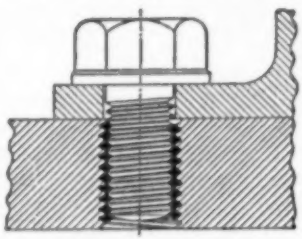

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Senior Engineer

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A MAJOR guided weapons contractor has six vacancies in its structures and aerodynamics departments.

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SALARIES and prospects of promotion on merit are excellent. Good working conditions, pensions scheme and welfare facilities.

APPLICATIONS, quoting D.O.24, giving details of age, experience, qualifications and salary required, should be addressed to the Personnel Manager, Aircraft Division, The Bristol Aeroplane Co., Ltd., Filton House, Bristol. [3301

BLACKBURN AND GENERAL AIRCRAFT LTD.

require a

SECTION LEADER

STRESSMAN

in their

LONDON DESIGN OFFICE

QUALIFICATIONS required are a degree or H.N.C. and a minimum of 4 years as a senior stressman.

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APPLICATIONS (in strict confidence) to: The Manager, Blackburn and General Aircraft, Ltd., 63, Old Brompton Road, S.W.7. [3299

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PERSONNEL Manager, Kelvin & Hughes, Limited, New North Road, Barkingside, Essex. [3291

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(*b*) **Intermediate and Senior Technical Engineers** in the Structures Analysis, the Aeroelasticity, the Power-control Sections, the Systems Group and the Engineering Development Laboratories where the facilities are modern and extensive.

A Degree or Higher National Certificate in Aeronautics, Mechanical or Structural Engineering is required.

(*c*) **Intermediate and Senior Technicians** in the Performance, Aerodynamics and the Wind Tunnel sections of the Aerodynamics Departments.

A Degree or Higher National Certificate in Aeronautics or Mechanical Engineering is required.

(*d*) **Designers, Technical Engineers and Aerodynamicists** in the Helicopter Design Offices.

Here, helicopter experience is desirable.

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Applications, giving details of experience, qualifications and salary required, quoting D.O.25, should be addressed to the **Personnel Manager, The Bristol Aeroplane Company Limited, Aircraft Division, Filton House, Filton, Bristol.**

SHOP FOREMAN

With previous experience preferably as foreman in aircraft industry. Required in connection with "Accountant" project in our new factory at Southend Airport, Southend-on-Sea, Essex.

Letters in the first instance with full details of previous experience and salary required to:

ENGINEERING MANAGER

AVIATION TRADERS (ENGINEERING) LTD.

SOUTHEND AIRPORT

SOUTHEND-ON-SEA, ESSEX

SITUATIONS VACANT

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THE Bristol Aeroplane Company Limited are inviting applications from suitably qualified and experienced technical engineers for a senior technical appointment in their London Design Offices at Haymarket House.

THE duties will include the control of a large design section responsible for the structural analysis of various aircraft. Experience of this type of work and some experience of staff supervision is essential.

A DEGREE in engineering, mathematics or science, or an equivalent professional qualification such as A.F.R.Ae.S. or A.M.I.Mech.E. is desirable.

APPLICATIONS, quoting L.D.O.2, giving details of age, experience, qualifications and salary required, should be addressed to the Personnel Manager, Aircraft Division, The Bristol Aeroplane Company, Limited, Filton House, Filton, Bristol. [3229

ROLLS-ROYCE, LTD., GLASGOW

ENGINEERING draughtsmen required for Hillington Factory on piston engine design and detail work. Applicants with H.N.C. preferred, but will be considered with minimum qualifications of O.N.C. Experience of aero or other internal combustion engine work desirable, but not essential.—Applications giving full details of age, experience and technical qualifications, should be addressed to Personnel Manager, Rolls-Royce, Ltd., Hillington, Glasgow, S.W.2. [3313

PILOTS required for

NIGERIA (Northern Region) on contract for 12/24 months in first instance. Salary scale (including expatriation pay) £1,469 rising to £1,631 a year. Commencing salary according to experience. Gratuity at rate of £150 a year. Outfit allowance £60. Free passages for officer and wife and assistance towards cost of children's passages or grant up to £150 annually for maintenance in U.K. Liberal leave on full salary. Candidates, preferably aged 30-40, must possess Commercial Pilot's Licence, instrument rating, and radio telephony licence, and must either hold a "full" Flying Instructor's Certificate from Guild of Air Pilots or belong to the A.I. R.A.F. Instructor category. They must have at least 2,000 hours as pilot-in-charge of single and twin-engined aircraft. Previous flying experience in tropical conditions an advantage. Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M3B/34694/FE. [3330

SITUATIONS VACANT

SENIOR DESIGN DRAUGHTSMAN

A SENIOR design draughtsman is required by the assistant chief engineer for aero engine and installation work in the new drawing office situated in the West End of London. Preference will be given to applicant possessing H.N.C. or equivalent. Aero engine experience desirable but not essential. Good salary, pension and life assurance scheme.—Full particulars, quoting E.D.30, to the Personnel Manager, The Bristol Aeroplane Co., Ltd., Engine Division, Filton House, Bristol. [3300

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Due to expansion of Design Laboratories, a vacancy exists for an

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A good degree and senior experience in the design of aircraft instruments or armaments essential; specialised knowledge of gyroscopes and/or servo systems would be an additional qualification.

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Assistance given, if desired, in obtaining accommodation.

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CHIEF ENGINEER.

SITUATIONS VACANT

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REQUIRE an assistant designer with suitable qualifications, experienced in design and stress work, and knowledge of M.o.S. procedure, to take charge of the design and stress sections in their Leeds office.

THIS position affords an opportunity to join an expanding organization and will provide scope for a man with ability and initiative.

APPLICATIONS, with full particulars, to be addressed to the Personnel Manager, Blackburn & General Aircraft, Ltd., Brough, E. Yorks. Mark envelopes "Design." [3334

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EAST AFRICA High Commission Directorate of Civil Aviation for one tour of 30 to 48 months in the first instance with prospect of permanancy. Salary scale (including inducement pay and present 10 per cent temporary allowance) £772 rising to £1,122 a year. Commencing salary according to experience. Good prospect of promotion to grade of radio superintendent (salary scale including inducement pay and 10 per cent allowance rising to £1,280 a year). Gratuity of 13½ per cent of total basic salary drawn during contract for those not taken on permanent establishment. Free passages. Liberal leave on full salary. Outfit allowance £30. Candidates must be capable of operating at 25 w.p.m. and should preferably hold M.C.A. 1st Class certificate in Radio Telegraphy. Knowledge of touch typing for teleprinter, the operation of modern radio or radar aids, or experience in radio maintenance would be an advantage.—Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/30606/FE. [3333

A PRIVATE company engaged in aircraft development and allied work requiring more than average initiative and ability now has vacancies for: —

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(c) Flight shed foreman

APPLICANTS should have thorough training in the aircraft industry up to recent developments.

EX-SERVICE personnel with appropriate technical skill and supervisory experience would be very suitable.

HOUSING would be available in reasonable space of time.

OUR existing staff are aware of this announcement.

APPLICATIONS to Box 2024. [3338

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SENIOR & INTERMEDIATE STRESSMEN

with adequate experience required for expanding office engaged in work on existing and new types of high-speed aircraft.

Minimum qualifications are Higher National Certificate or B.Sc.(Eng.) with appropriate subjects.

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Applications for interview should be made to the Chief Stressman at the above address.

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FOR

AIRCRAFT DESIGN DRAUGHTSMEN
(SENIOR & JUNIOR)

Consideration will also be given to Draughtsmen with Mechanical, Structural or Electrical experience.

Also

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(SENIOR & INTERMEDIATE)
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CHIEF DESIGNER

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GENEROUS salaries and houses available to suitable applicants. Interviews either in London, Bracknell or Weymouth.—Apply to Burton House, High Street, Bracknell, Berks, or Telephone Bracknell 376. [3316

SKYWAYS require skilled airframe fitters at Bovingdon Airport. Men with Hermes and/or Hastings experience preferred.—Write, call or phone Administrative Superintendent, Skyways, Ltd., Bovingdon Airport, Hemel Hempstead, Herts. [3310

PART-TIME flying instructors required for regular work at week-ends and on summer evenings. Only conscientious men with current licences (commercial preferred, but not essential) and GAPAN endorsements need apply. London area. Box 1981. [3329

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ADVERTISER arriving United Kingdom March 1st for interviews.—Reply to: Pilot, c/o W. H. R. Beckitt, "Lynclys," near Oswestry, Shropshire. [3307

SENIOR and intermediate design draughtsmen with aircraft and mechanical engineering experience required. The work will interest men who can apply their design ability to the development of new equipment which has a steadily growing application. Pleasant working conditions; 5-day week. Within easy reach of Bournemouth. Special transport facilities provided.—Apply in writing to Personnel Manager, Flight Refuelling, Ltd., Tarrant Rushton Airfield, near Blandford, Dorset. [3270

TECHNICAL AUTHORS

are required in the Aircraft Division of

THE ENGLISH ELECTRIC CO. LTD.

AT WARTON AERODROME, NEAR PRESTON

Previous experience is desirable, but consideration will be given to ex-R.A.F. ENGINEERS who have the appropriate experience and qualifications. Reply to **Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. 1380.**

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London Airport, Hounslow
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SITUATIONS VACANT

EXPERIENCED draughtsmen required for design work on complete aircraft, located London area. Interesting civil project, permanent position, substantial, expanding organization.—Reply, full details London Office, Edgar Percival Aircraft, Ltd., 72 Chesterfield House, Curzon Street, London, W.1. [3341

CHIEF engineer required immediately to maintain and service Harvard and Chipmunk aircraft. Must hold at least A and C Licences and have a knowledge of R.A.F. servicing procedures. This is a permanent post and only applicants with the necessary qualifications and experience need apply.
PLEASE apply in writing to Goodhew Aviation Company, Limited, Oxford Airport, Kidlington, Oxford. [3294

EAST AFRICAN AIRWAYS CORPORATION require an operations officer, preferably ex-R.A.F. navigator. Knowledge of civilian procedure preferred. Initial probationary period followed by contract, if suitable, with home leave entitlement.—Apply, with qualifications to Personnel Officer, P.O. Box 1010, Nairobi, Kenya. [3318

CHIEF draughtsman required for small design and production drawing office dealing with electro-mechanical aircraft and precision instruments. Knowledge of service specifications and procedure essential. Croydon area. Pension scheme. Age 30/40 years.—Full details of experience and salary required to Box 2023. [3337

HELLIWELLS, LTD., Aircraft Division, Elmdon Airport, Birmingham, have vacancies for two design section leaders for interesting aircraft design work of high priority. Only first-class aircraft men will be considered, but excellent rates will be paid to the successful applicants.—Full details of training and experience, etc., to Personnel Manager. [3250

FERRANTI, Limited, Edinburgh, have vacancies for aircraft draughtsmen. Experience in aircraft installation work desirable but not essential.—Apply, quoting Ref. 29 D.D.O., and give full details of training and experience in chronological order to the Personnel Officer, Ferranti, Limited, Ferry Road, Edinburgh 5. [3247

AIRCRAFT Engineer required preferably with A, B and C licences covering light aircraft or A and C with ability to take B coverage in a reasonable time; must be good all-round engineer, experienced in club work and capable of working on his own. Write giving experience and salary required to The Scottish Flying Club, Renfrew Airport. [3327

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MANUFACTURERS of precision aircraft components offer permanent and progressive posts to engineers interested in development of power-operated flying controls, hydraulic systems and fuel metering systems. Expenses paid to applicants attending interviews.—Apply giving age, full details of education, experience and salary required to: H. M. Hobson, Ltd., Fordhouses, Wolverhampton, Staffs. [3245

PLANNING engineer required with experience of aircraft repair, overhaul and conversion on civil and military aircraft. Applicants must have had a sound all-round experience on the above work and be conversant with up-to-date production control methods as applied to this type of work.—Apply in writing to Personnel Manager, Field Aircraft Services, Ltd., Croydon Airport, Croydon, Surrey. [3344

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HELLIWELLS, LTD., Aircraft Division, Elmdon Airport, Birmingham, urgently require draughtsmen, all grades, preferably with aircraft installation experience, but others with good light engineering experience considered. The work is interesting and of high priority and good opportunities of advancement with this expanding company are open to the right men.—Send full details to Personnel Manager. [3351

WIRELESS Operator required with First Class M.C.T.A. Licence preferably with experience on test-flying duties for a position at Nottingham. The successful applicant will form part of the aircrew who are carrying out test flights on civil and military aircraft. Applicants should also have experience on American equipment as fitted to Dakota military aircraft. Apply to Personnel Manager.
FIELD AIRCRAFT SERVICES, LIMITED, Croydon Airport, Surrey. [3328

ENGINEERING vacancies exist in the Installation Department of Smiths Aircraft Instruments, Cheltenham, for work on auto controls for aero gas turbines. Some experience of engine installations, accessories and/or electrical and hydraulic servo-mechanisms is required. Applicants should be qualified engineers, have a medical standard equivalent to Class "A" Life Insurance, and should be willing to travel within the U.K. and abroad.
THE starting salary will depend on qualifications, age and experience.—Applications with details of qualifications, experience and salary required should be made in writing to the Personnel Department, S. Smith and Sons, Ltd., Bishop's Cleeve, nr. Cheltenham, Glos., quoting reference 52/EN." [3345

SITUATIONS VACANT

DE HAVILLAND AIRCRAFT COMPANY, LTD., Airspeed Division, Christchurch, nr. Bournemouth, Hants, require additional staff for technical leaflets section. See Press reports of new design and development work. Applications to be addressed to the Chief Draughtsman. [3350

APPLICATIONS are invited for post of senior draughtsman with a well-known company of instrument manufacturers. Experience in design of small electro-mechanical devices is essential. Salary in accordance with experience. Employment agencies are invited to reply.—Write, Box 2548, Frost-Smith Advg., 64 Finsbury Pavement, London, E.C.2. [3251

ARMSTRONG SIDDELEY MOTORS has vacancies for technical assistants in their main engine development department. The work deals with the development of all types of company's aero engines from their earliest inception. Applicants must possess at least a Higher National Certificate in Mechanical engineering. Being an expanding department the prospects and initial salary are good.—Apply to Reference CG/X2, Technical Personnel Manager, Armstrong Siddeley Motors, Coventry. [3256

ELECTRICAL engineers, senior and junior, are urgently required for the Engine Controls Department of Smiths Aircraft Instruments, Ltd., at Cheltenham. The work embraces research and development on automatic controls for aero gas turbines, magnetic amplifiers and electro-mechanical control units. Applicants should have some experience of magnetic amplifiers, electronics, small electro-mechanical instruments or theoretical or practical aspects of servo-mechanisms.
THE positions are permanent and carry generous salaries commensurate with experience and qualifications. A pension scheme is available.—Applications with full details of qualifications, experience, and salary required, should be made to: Personnel Manager, Smiths Aircraft Instruments, Ltd., Bishop's Cleeve, nr. Cheltenham, quoting reference 51/EN. [3342

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with experience in the following:

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HELLIWELLS, LTD., Aircraft Division, Elmdon Airport, Birmingham, have vacancies for two design section leaders for interesting aircraft design work of high priority. Only first-class aircraft men will be considered but excellent rates will be paid to the successful applicants.—Full details of training and experience, etc., to Personnel Manager. [3352

IMPERIAL CHEMICAL INDUSTRIES, LTD., Metals Division, has a vacancy for an engineer to assist in the sales and sales development of heat transfer equipment and the materials used in such equipment. Applicants should preferably have a degree in mechanical engineering or equivalent qualification. Previous industrial or research experience would be an advantage but not essential. The principal requirements are a suitable personality and a genuine interest in heat transfer theory and practice. Salary will be dependent on qualifications and experience and there is ample scope and opportunity for promotion.—Application forms may be obtained from Assistant Staff Manager, I.C.I. Metals Division, Kynoch Works, Witton, Birmingham 6, quoting TS/1. [3343

SITUATIONS VACANT

LICENCED engineer and airframe engineers, Rapide specialists, preferably single, required for employment Middle East, two years contract.

APPLICATIONS Blanford & Houdret, Ltd., 37/38 Fenchurch Street, London, E.C.3. [3335

JIG and tool draughtsmen required with experience of precision mechanical engineering allied to the aircraft industry. Superannuation scheme.—Apply Personnel Officer, Sir George Godfrey & Partners, Ltd., Hampton Road West, Hanworth, Middlesex. [3336

JOSEPH LUCAS (GAS TURBINE EQUIPMENT), LTD., invite applications from young men with engineering background, preferably with degree, Higher National Certificate or National Certificates in Mechanical or Electrical Engineering, for training as designers of gas turbine equipment. These appointments are pensionable and offer exceptional opportunities to men with initiative. Applications should be sent to the Personnel Manager, Joseph Lucas (Gas Turbine Equipment), Ltd., Shaftmoor Lane, Hall Green, Birmingham, 28. [3296

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TRIALS DEPARTMENT
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(b) To work in the Field Trials Section as members of trials teams concerned with the preparation and flight testing of sub-miniature electronic apparatus. Applicant should be willing to work away for short periods and should have experience of V.H.F. and U.H.F. radio techniques. Qualifications: City Guilds or H.N.C. in Radio or Telecommunications Engineering.

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2. DRAUGHTSMEN

(a) For the design of test rigs and associated hydraulic and pneumatic equipment. Aircraft experience is desirable. Qualifications to O.N.C. (Mech.) standard.

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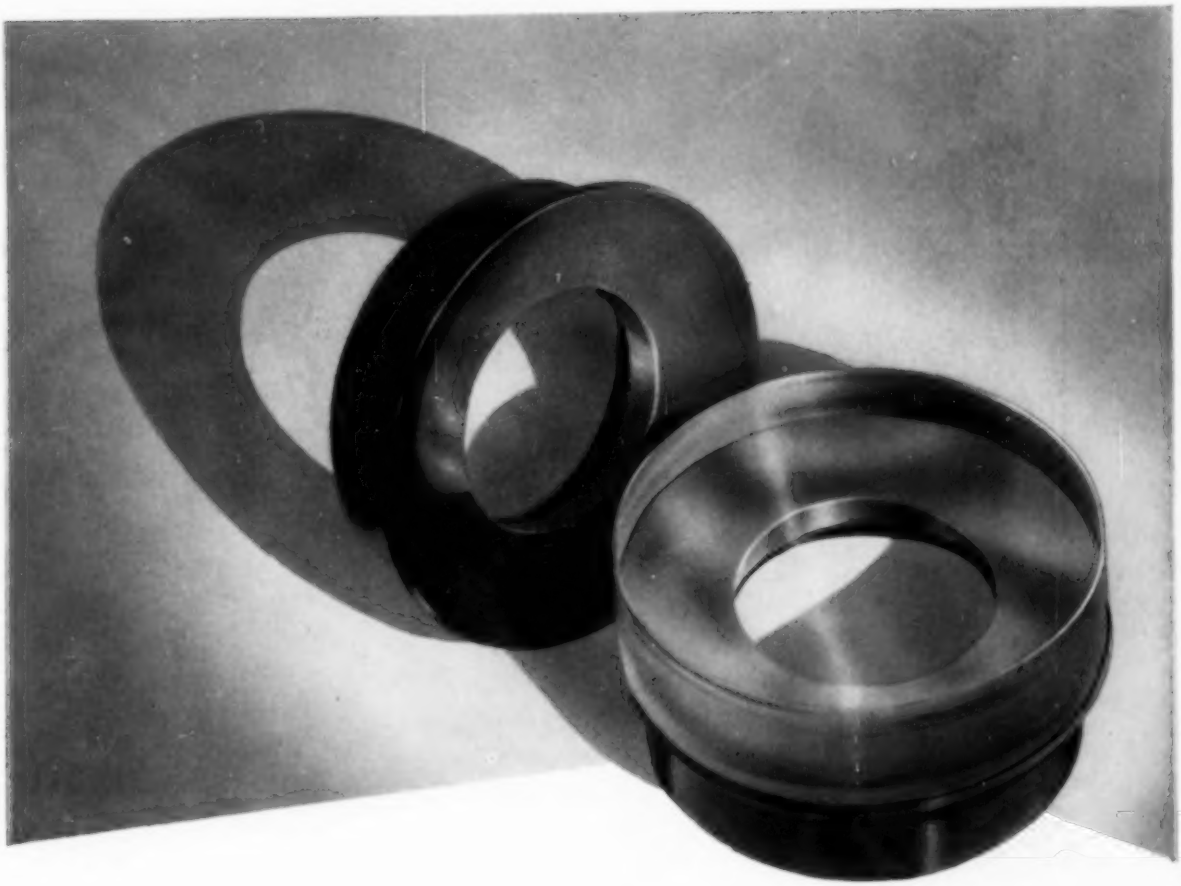

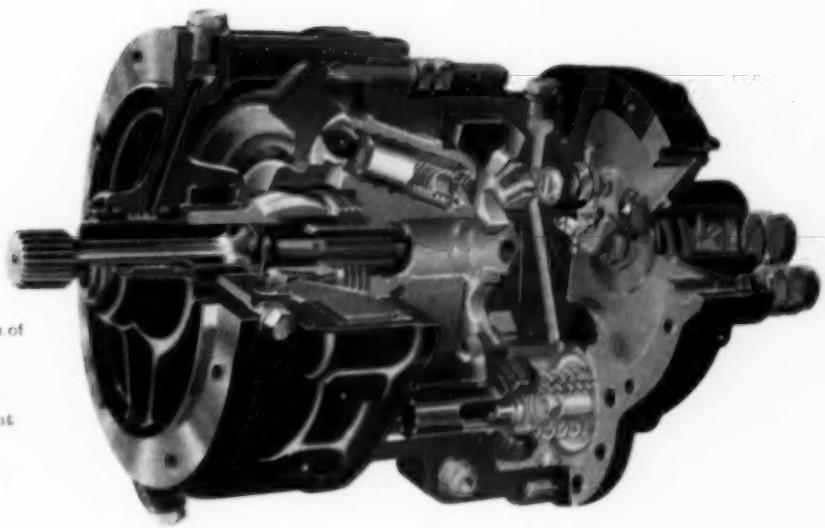

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